-CONTROL MULTIMETER

FEBRUARY 1960

Radio-Electronics

HUGO GERNSBACK, Editor

TYPE 532 OSCILLOSCOPE
FOCUS
INTENSITY
ASTIGMATISM
SCALE ILLUM.
POLARITY
VERTICAL POSITION
TYPE 53/54C PLUG-IN UNIT
HORIZONTAL POSITION

Electronic Voltage Regulator For Your Car

Motors Balanced By Electronics

New Circuit Kills P-A Howl

See page 4

0c

BOB G MAHRENHOLZ 4-63
624 CIRCLE DRIVE
TULLAHOMA TENN

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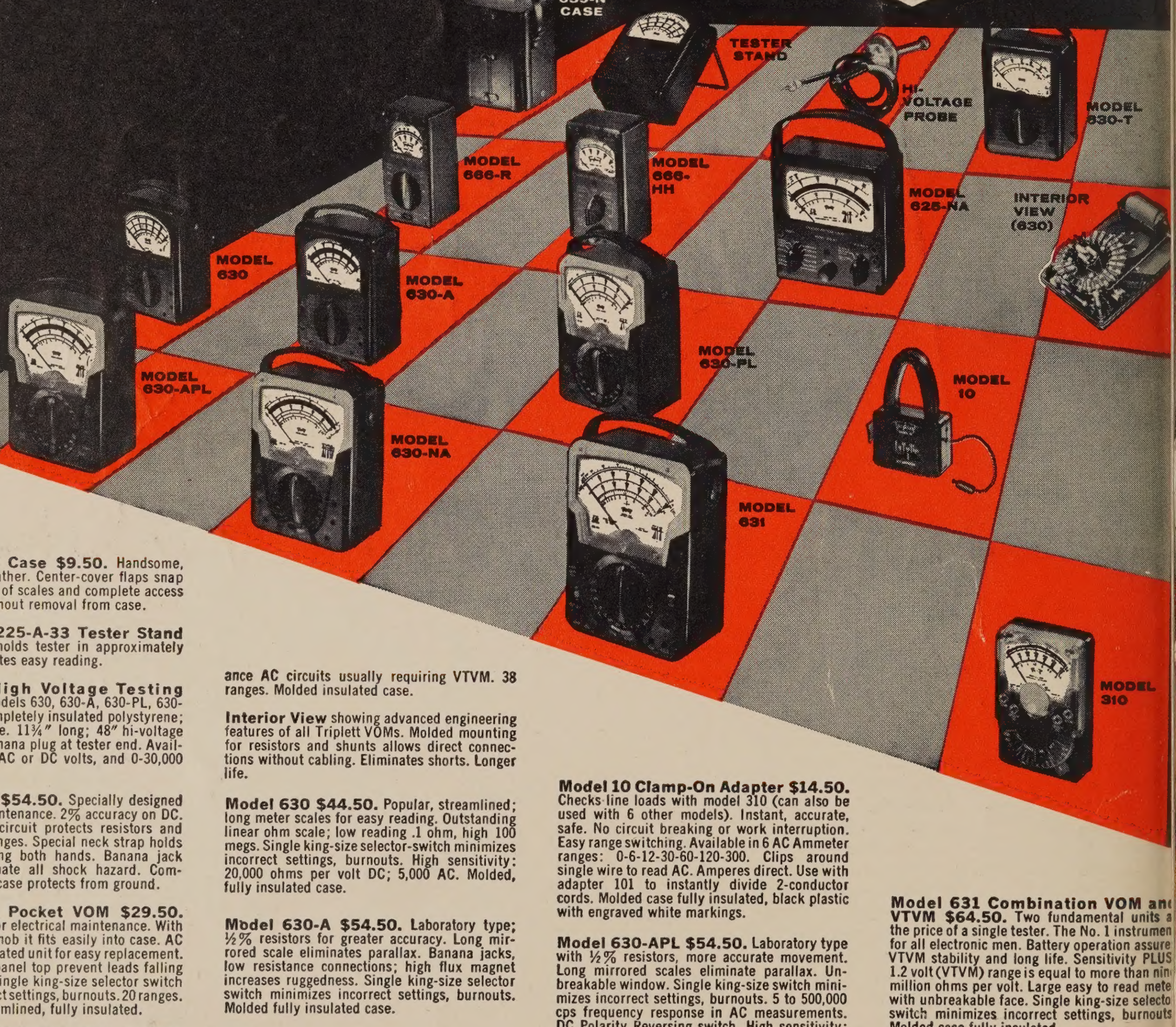

Model 639-N Case $9.50. Handsome, black cowhide leather. Center-cover flaps snap back for full view of scales and complete access to instrument without removal from case.

Model Pt. T-225-A-33 Tester Stand $0.50. Metal, holds tester in approximately 45° angle; facilitates easy reading.

Probe for High Voltage Testing $14.50. For models 630, 630-A, 630-PL, 630-APL, and 631. Completely insulated polystyrene; guard-type handle. 11¾" long; 48" hi-voltage wire lead with banana plug at tester end. Available in 0-12,000 AC or DC volts, and 0-30,000 AC or DC volts.

Model 630-T $54.50. Specially designed for telephone maintenance. 2% accuracy on DC. Fused protected circuit protects resistors and meter in ohms ranges. Special neck strap holds instrument, freeing both hands. Banana jack connectors eliminate all shock hazard. Completely insulated case protects from ground.

Model 666-R Pocket VOM $29.50. Hand size, ideal for electrical maintenance. With recessed range knob it fits easily into case. AC rectifier pre-calibrated unit for easy replacement. Banana jacks at panel top prevent leads falling over meter dial. Single king-size selector switch minimizes incorrect settings, burnouts. 20 ranges. Molded case streamlined, fully insulated.

Model 666-HH Pocket VOM $27.50. Compact, hand-size; 3" meter integral with panel, adjusted to 400 microamperes at 250 millivolts. Only 3 jacks necessary for all ranges. 19 ranges.

Model 625-NA $54.50. Dual sensitivity for extra ranges; large mirror scale for super readability. 3-color meter scale 5" long. 6" instrument, 0-50 microamp. AC volts at 10,000 O/V for checking many audio and high impedance AC circuits usually requiring VTVM. 38 ranges. Molded insulated case.

Interior View showing advanced engineering features of all Triplett VOMs. Molded mounting for resistors and shunts allows direct connections without cabling. Eliminates shorts. Longer life.

Model 630 $44.50. Popular, streamlined; long meter scales for easy reading. Outstanding linear ohm scale; low reading .1 ohm, high 100 megs. Single king-size selector-switch minimizes incorrect settings, burnouts. High sensitivity: 20,000 ohms per volt DC; 5,000 AC. Molded, fully insulated case.

Model 630-A $54.50. Laboratory type; ½% resistors for greater accuracy. Long mirrored scale eliminates parallax. Banana jacks, low resistance connections; high flux magnet increases ruggedness. Single king-size selector switch minimizes incorrect settings, burnouts. Molded fully insulated case.

Model 630-PL $44.50. Instant-vision, wider spread scales; streamlined case; handsome modern design. Unbreakable window. Outstanding linear ohm scale; low reading .1 ohm; high to 100 megs. Single king-size selector switch minimizes incorrect settings, burnouts. 5 to 500,000 cps frequency response in AC measurements. DC Polarity Reversing switch. High sensitivity: 5,000 ohms per volt AC; 20,000 ohms per volt DC.

Model 10 Clamp-On Adapter $14.50. Checks line loads with model 310 (can also be used with 6 other models). Instant, accurate, safe. No circuit breaking or work interruption. Easy range switching. Available in 6 AC Ammeter ranges: 0-6-12-30-60-120-300. Clips around single wire to read AC. Amperes direct. Use with adapter 101 to instantly divide 2-conductor cords. Molded case fully insulated, black plastic with engraved white markings.

Model 630-APL $54.50. Laboratory type with ½% resistors, more accurate movement. Long mirrored scales eliminate parallax. Unbreakable window. Single king-size switch minimizes incorrect settings, burnouts. 5 to 500,000 cps frequency response in AC measurements. DC Polarity Reversing switch. High sensitivity: 5000 ohms per volt AC; 20,000 ohms per volt DC. Molded case fully insulated.

Model 630-NA $74.50. Super DeLuxe with 70 ranges—nearly double conventional types. Frequency compensated from 35 cps to 20 kc. Temperature compensated. Accurate within 1½% full scale reading on DC. Large open front meter easy to read. Unbreakable window. Mirrored scale. Meter protection against overloads. Molded fully insulated case.

Model 631 Combination VOM an VTVM $64.50. Two fundamental units a the price of a single tester. The No. 1 instrumen for all electronic men. Battery operation assure VTVM stability and long life. Sensitivity PLUS 1.2 volt (VTVM) range is equal to more than nin million ohms per volt. Large easy to read mete with unbreakable face. Single king-size selecto switch minimizes incorrect settings, burnouts Molded case fully insulated.

Model 310 $34.50. The only complet miniature VOM with 20,000 ohms per volt an selector range switch. Self-shielded agains strong magnetic field. Rugged, high torque, bar ring instrument. Unbreakable plastic mete window. Converts to common probe—frees on hand—by fitting interchangeable test prod int top. Standard sensitivity 20,000 ohms per vol DC, and 5,000 ohms per volt AC. Accuracy 3% DC. Molded fully insulated case.

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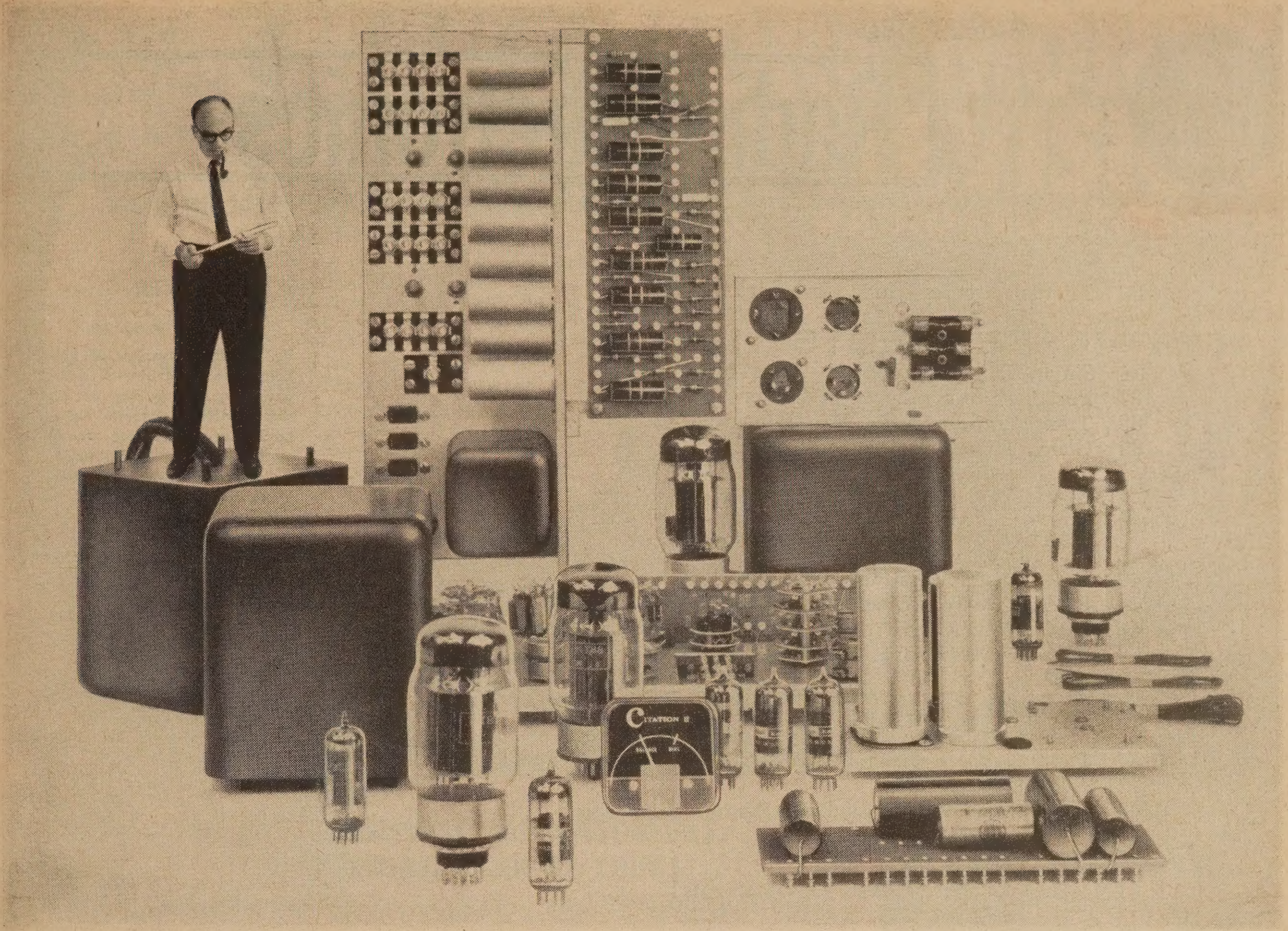
BLUFFTON, OHIO



We don't pack an engineer into each new Citation Kit but...

...the engineering *built into* each kit is so precise that the unit constructed in the home will be the equal of the factory-produced instrument.

It is far more difficult to design a kit than to produce a completely manufactured product. In the plant the engineer can control his design from the moment of inception until the final packaging. The kit builder has only his tools, his ingenuity and little, if any, test equipment.

Therefore, the complex process of in-plant production and control which guarantees the fine finished product must somehow be *embedded* in the kit design. The Citation engineering group at Harman-Kardon, headed by Stewart Hegeman, has succeeded in doing just this in the design of the new Citation I, Stereophonic Preamplifier Control Center and Citation II, 120 Watt Stereophonic Power Amplifier.

Only heavy duty components, operating at tight tolerances, have been selected for the Citation Kits. As a result, even if every component is operated at its limit – remote as this possibility is – the instruments will perform well within their specifications.

Rigid terminal boards are provided for mounting resistors and condensers. Once mounted, these components are suspended tightly between turret lugs. Lead length is sharply defined. The uniform spacing of components and uniform lead length insure the overall stability of the unit.

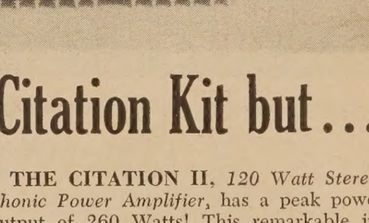
Improper routing of leads, particularly long leads, can result in unstable performance. To prevent this, the Citation II is equipped with a template to construct a Cable Harness. The result: each wire is just the right length and in just the right place to achieve perfect performance.

These truly remarkable achievements in Control Engineering are only a few of the many exciting new developments in kit design from the Citation Division of Harman-Kardon.

THE CITATION I, *Stereophonic Preamplifier Control Center,* is a brilliantly designed instrument, reflecting engineering advances found only in the best professional equipment. The control over program material offered by the new Citation I enables the user to perfectly re-create every characteristic of the original performance. (The Citation I – $139.95; Factory-Wired – $239.95; Walnut Enclosure, WW-1 – $29.95.)

THE CITATION II, *120 Watt Stereophonic Power Amplifier,* has a peak power output of 260 Watts! This remarkable instrument will reproduce frequencies as low as 5 cycles virtually without phase shift, and frequencies as high as 100,000 cycles without any evidence of instability or ringing. *At normal listening levels, the only measurable distortion in this unit comes from the laboratory testing equipment.* (The Citation II – $159.95; Factory-Wired – $219.95; Charcoal Brown Enclosure, AC-2 – $7.95.) All prices slightly higher in the West.

Harman-Kardon has prepared a free detailed report on both of these remarkable new instruments which we will be pleased to send to you. Simply write to Dept. RE-2, Citation Kit Division, Harman-Kardon, Inc., Westbury, L. I.



Citation I

Build the Very Best CITATION KITS *by* harman kardon

OVER 50 YEARS OF ELECTRONIC PUBLISHING

FEBRUARY, 1960

Radio-Electronics

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Dr. M. R. Schroeder of Bell Telephone Laboratories demonstrates the action of his signal-shifting acoustic feedback preventer. Top trace on scope shows signal build-up without shifting; bottom trace is same signal with shifting.

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News Briefs

ELECTRONICS AND JETS may combine to revolutionize distribution of high-value low-bulk merchandise if a new concept in distribution pioneered by Raytheon spreads to distribution of other similar merchandise.

The Raytheon plan includes data-processing machines for receiving and dispatching orders, controlling inventories and keeping accounts, and deliveries largely by jet cargo planes which make the entire country "5 hours wide and 3 hours deep," according to American Airlines, who cooperated in setting up the system.

Special punch-card equipment designed and installed by Western Union can accept a typical order in 17 minutes, fill it in 90 minutes and deliver it to a jet plane at the airport in 45 minutes, making it possible to fill orders anywhere in the United States within 24 hours after the order is placed.

Tel-O-Riginator equipment will be installed first in the 25 district offices of Raytheon's Distributor Products Div., and eventually in the offices of all major distributors of Raytheon products.

NO MORE WOOFERS & TWEETERS? So goes the suggestion of Dr. Amar G. Bose, MIT professor who recently patented a speaker system which uses a one-eighth segment of a sphere covered with 22 identical small cones, placed in a corner of the room. Effectively, the whole spherical surface moves in unison to make those bass notes boom right. Somewhat similar systems, not usually in corners, have been in private use for several years.

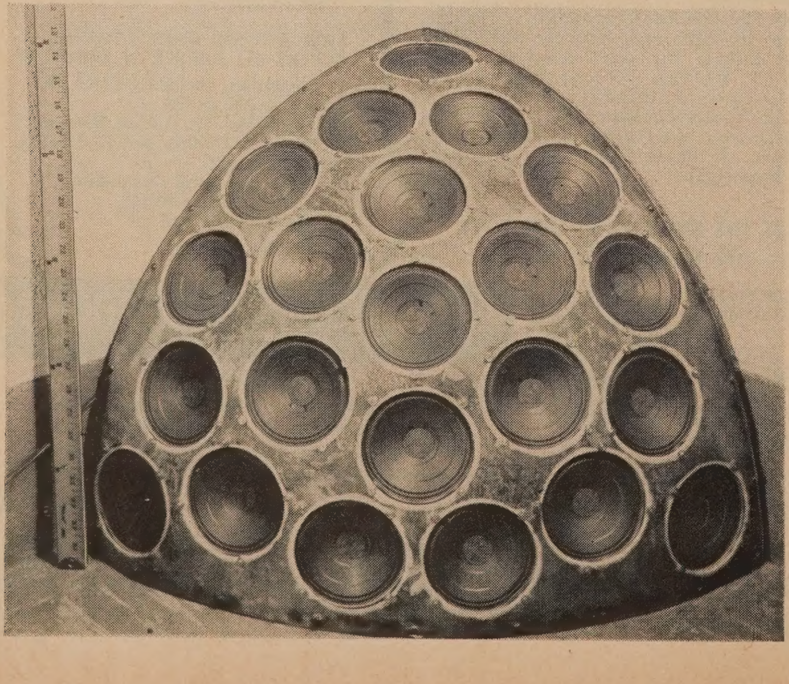
MARS TECHNICAL NET schedule for February: Feb. 3, "Quartz Crystals in SSB Filters," W. E. Benton; Feb. 10, "Design Philosophy of a Modern SSB Transceiver," Chick Carny; Feb. 17, "Distortion in High-Fidelity Amplifiers," Milton Snitzer; Feb. 24, "High-Power Transmitter Stations," Herbert Hawkins.

Sessions will continue each Wednesday at 9 p.m. EST, 4030 kc, upper sideband, with discussion via net radio following each talk.

FM STATION was given away in New York. WBAI-FM, good music station belonging to Louis Schweitzer, chemical engineer and industrialist, was presented by him to nonprofit Pacifica Foundation, to become a listener-sponsored, no-advertising station.

The station will broadcast classical music, with jazz, folk music, children's shows and public affairs programs also aired. Listeners will be asked (but not pressed) to send in $12 a year to sponsor the station.

A similar operation has been run by Pacifica in Berkeley, Calif., since 1949. KPFA-FM is now nearly self-supporting, with 7,500 paying listeners. Pacifica opened a second station, KPFK-FM, in Los Angeles in mid-1959 and has almost 5,000 paid subscribers to date.



FIRST BROADCAST of opera made by Lee de Forest from the Metropolitan Opera House in New York City Jan. 13, 1910, was celebrated through the month of January with a special exhibit by the New York Public Library. Exhibit included all collectable memorabilia on the historic event.

TRANSISTOR TELEVISION set by Emerson was scheduled to go into production this winter. Size of screen was not definitely decided but officials said it would be a full-size picture tube, not a small optically enlarged one like Philco's 2-inch tube-with-lens. The price was expected to be near that of Philco's portable set, $250. Emerson said its transistors would be American-made.

IRE WILL HONOR Dr. Harry Nyquist, authority on feedback analysis, along with Haraden Pratt, J. A. Rajchman, J. W. Gewartowski, K. A. Norton, and E. J. Nalos. Dr. Nyquist will receive the society's 1960 Medal of Honor "for fundamental contributions to a quantitative understanding of thermal noise, data transmission, and negative feedback." Mr. Pratt will get the Founder's Award, the Institute's second highest award, which is bestowed only on special occasions. Seventy-six engineers will be elevated to the rank of Fellow. Among them is William Sichak of ITT, whose picture appeared on our February, 1959, cover.

New officers of the IRE for 1960 include Ronald McFarlan, consultant to Datamatic and Raytheon, president; J. N. Dyer, Airborne Instruments, vice president; and J. A. Ratcliffe, Cavendish Labs (England), vice president.

ANECHOIC RF TEST RANGE, in effect, is the antenna test setup at Technical Appliance Corp. between two hilltops in Sherbourne, N. Y., where a 3,000-foot valley between transmitter and receiver location provides near-free-field conditions for checking new antenna designs. Towers installed can handle antennas up to 60 feet in diameter.

MEDICAL ELECTRONICS took another step forward with the introduction of an optical probe consisting of thousands of minute spun-glass fibers bound together, with a small lens focusing on their ends. Each of the fibers picks up light from a minute section of the surface ahead of it and transmits it to the other end. The mosaic of spots of light

(*Continued on page* 10)

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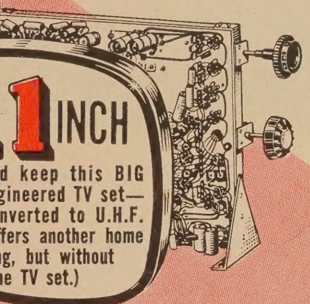

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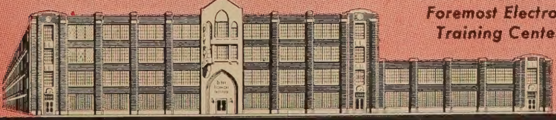

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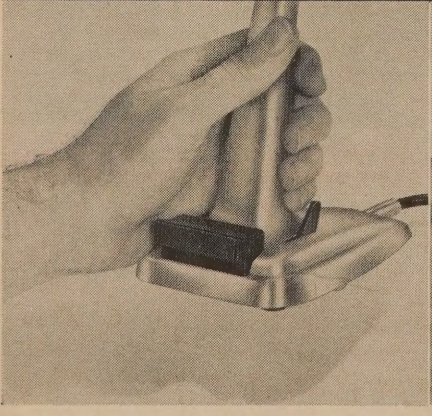
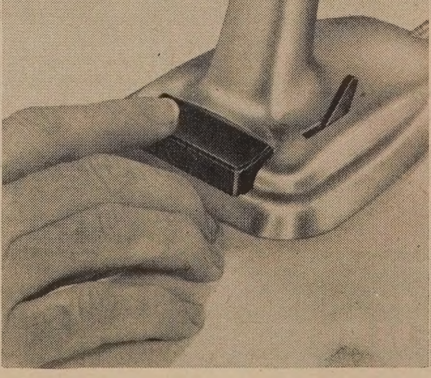


LIFT THE MIKE, IT'S LIVE. Additional slide lock switch in base deactivates lift switch when necessary.



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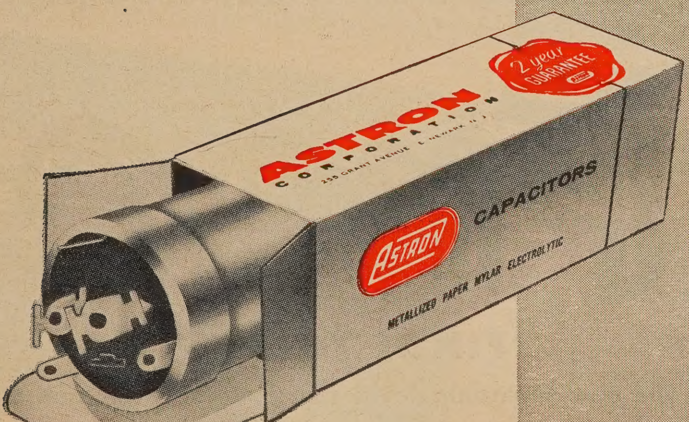
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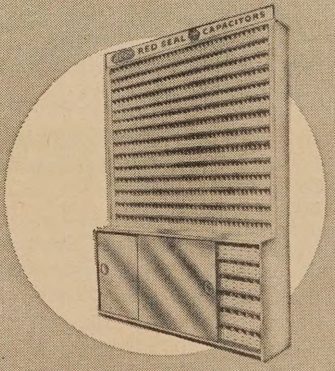
RED SEAL CAPACITORS

Look for the Red Seal
Capacitor Display Cabinet
at your " DISTRIBUTOR "

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CORPORATION
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SEND IMMEDIATELY FOR OUR NEW ALL INCLUSIVE REPLACEMENT CATALOG.

is scanned, then displayed up to 35 times life-size on TV monitors.

Dental and surgical work previously unavailable for observation can now be examined by doctors or classes while operations are in progress.

Calendar of Events

ISA Instrument-Automation Conference and Exhibit, Feb. 2–4, Sam Houston Coliseum, Houston, Tex.

Winter Convention on Military Electronics, Feb. 3–5, Ambassador Hotel, Los Angeles, Calif.

Solid State Circuits Conference, Feb. 10–12, University of Pennsylvania, Philadelphia, Pa.

Cleveland Electronics Conference, Feb. 11–12, Engineering and Scientific Center, Cleveland, Ohio.

ERA National Convention, Feb. 11–13, Drake Hotel, Chicago, Ill.

EP&EM Educational Seminar, Feb. 16, Niles, Ill.

ERA Southern California Chapter Distributor - Representative - Manufacturer Conference, Feb. 18-20, Palm Springs, Calif.

Distributor - Representative - Manufacturer Conference, Feb. 18–21, El Mirador Hotel, Palm Springs, Calif.

International Electronic Parts Show, Feb. 19–23, Parc des Expositions, Porte de Versailles, Paris, France.

Annual EIA Industrial Relations Conference, Feb. 24-26, Hollywood Beach Hotel, Hollywood, Fla.

Scintillation Counter Symposium, Feb. 25–26, Washington, D. C.

EIA Spring Conference, Mar. 16-18, Hotel Statler, Washington, D.C.

IRE National Convention, Mar. 21-24, Coliseum & Waldorf Astoria Hotel, New York, N.Y.

Hi-Fi Show

IHFM Hi-Fi Show, Mar. 25-27, National Guard Armory, Washington, D.C.

Details on all events supplied by sponsoring organizations.

FRAUD IN TV REPAIR was charged against Fairfax County, Virginia, service dealer T. M. Lowery for charging $36.30 for repairs he didn't make. Found guilty by Judge J. N. Groves, Lowery was given 15 days in jail, plus a suspended sentence for a year. A detective testified at the trial that all Lowery actually did was replace two small tubes, one unnecessarily, although his bill included such items as "reworking" a sound circuit, reworking the video circuit, restoring high voltage and adjusting the channel selector.

MICROMINIATURE CIRCUITS that cost no more than the same ones built with standard components were demonstrated at a press conference by Aerovox's Hi-Q division at their Olean, N.Y., plant. The photo shows a complete adder circuit designed for use in a ballistic missile computer. It is 50 times smaller than conventional units, measures only ½ x ½ x 1 inch and contains 85 components. These units are not the smallest that can be made, but are the smallest ones that can be made at a

(*Continued on page* 14)

How to Get

An FCC License can be

Get Your FCC License

We Guarantee
to train you until you receive
Your FCC License
— or your money back

The Master Course in Electronics will provide you with the mental tools of the electronics technician and prepare you for a First Class FCC License (Commercial) with a radar endorsement. When you successfully complete the Master Course, if you fail to pass the FCC examination, you will receive a full refund of all tuition payments.

Cleveland Institute Training Results in success with commercial FCC examinations . . . easily . . . and quickly.

Free!

FIND OUT HOW:

1. The new electronic devices can be handled by you
2. To solve the problems that will stump your fellow technicians
3. Training is Job Insurance when employment is tough to find . . . and more money for you when times are good

Mail Coupon NOW . . .

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in a Minimum of Time

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here's proof of good jobs

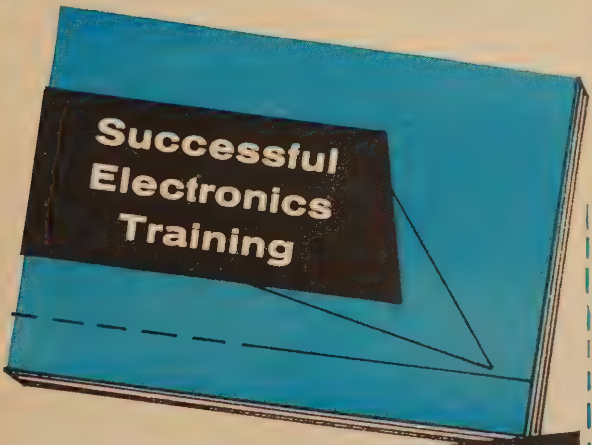
Irving Laing:

"Your lessons are helping me a lot in my Navy work. You cover topics that were not presented by the Navy at the E.T. School. . . . Your course has helped greatly to get my 2nd class FCC ticket. I am now a radio and T.V. engineer at WTVS and WDTR in Detroit, Michigan."

Irving L. Laing,
15887 Robson,
Detroit 27, Michigan

Get all 3 FREE

How to get a Commercial FCC License
Opportunities in Electronics for You
How To Be SUCCESSFUL in ELECTRONICS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Accredited by The National Home Study Council

Cleveland Institute of Electronics

Desk RE 38B, 4900 Euclid Ave., Cleveland 3, Ohio

Please send FREE Booklets prepared to help me get ahead in Electronics. I have had training or experience in Electronics as indicated below:

☐ Military
☐ Radio-TV Servicing
☐ Manufacturing
☐ Amateur Radio
☐ Broadcasting
☐ Home Experimenting
☐ Telephone Company
☐ Other............

In what kind of work are you now engaged?.............
....

In what branch of Electronics are you interested?..........
....

Name.. Age......
Address...
City............................... Zone...... State......

Desk RE 38B

ONE WAY
ELECTRONS
5U4GB
CBS

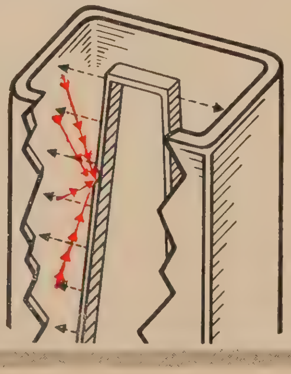
My new plates behave like plates... not filaments

**(FORGET YOUR
LOW-VOLTAGE
RECTIFIER PROBLEMS)**

HOW BACK EMISSION IS ELIMINATED

Back emission from overheated plate to filament causes most rectifier failures. Reverse current mounts . . . filament is stripped . . . overheats . . . burns out.

That's why the new CBS 5U4GB plates are of non-emissive material, are larger, and run cooler. These and many other advance engineered features make the new CBS 5U4GB the best you can buy. Here's typical proof. Dynamic "blast" tests brutally cycle the tube between 4 and 6.8 volts with 800 volts plate potential. Yet back emission is just measurable . . . less than one milliampere!



"My new plates don't heat up and start acting like filaments. They can't because my plate material is designed not to emit wrong-way electrons. So back emission can't build up and burn out my filament. And you aren't pestered with premature failures."

That is right. The new CBS 5U4GB offers you *total reliability* . . . proved in performance by leading TV and radio set manufacturers. You, too, can profit from the *total reliability* of CBS tubes. Just replace with CBS . . . always.

TOTAL RELIABILITY... proved in performance

CBS
tube
CBS
tube
Guaranteed by Good Housekeeping

*Receiving, industrial
and picture tubes
transistors and diodes
audio components
and phonographs*

CBS ELECTRONICS
Danvers, Massachusetts
A Division of Columbia Broadcasting System, Inc.

COLUMBIA RECORD CLUB offers with pride
the greatest musical achievement since the introduction of stereo records

The first complete recordings of the

9 SYMPHONIES of BEETHOVEN

conducted by

BRUNO WALTER

reproduced in glorious

STEREO

ALL FOR ONLY **$5.98**

REGULAR RETAIL VALUE, $41.98

if you join the Club now and agree to purchase as few as six selections from the more than 150 to be made available during the coming 12 months

". . . a noble exposition of Beethoven as seen by one of the greatest of his prophets" — **High Fidelity Magazine**

"A collection which stands as near the pinnacle of perfection as any human product ever can"
— **San Francisco Chronicle**

DELUXE PACKAGE
Seven 12" Columbia stereo records in a luxurious box, covered with white leather-like Fabrikoid and lustrous black-and-gold cloth. Also includes 48-page booklet with previously unpublished photographs; program notes; anecdotes and reviews by Beethoven's contemporaries and present day critics.

NOTE: Stereo records must be played only on a stereo phonograph

THE CORNERSTONE OF ANY STEREO LIBRARY...

If you now own a stereo phonograph, or plan to purchase one soon, here is a unique opportunity to obtain — for only $5.98 — this magnificent Columbia 7-Record Set containing all nine Beethoven Symphonies . . . in glowing performances by one of his greatest interpreters, Dr. Bruno Walter . . . and reproduced with amazingly realistic "concert hall" fidelity through the miracle of stereophonic sound!

TO RECEIVE YOUR BEETHOVEN SET FOR ONLY $5.98 — simply fill in and mail the coupon now. Be sure to indicate which one of the Club's two Divisions you wish to join: Stereo Classical or Stereo Popular — whichever one best suits your musical taste.

HOW THE CLUB OPERATES: Each month the Club's staff of music experts selects outstanding recordings from every field of music. These selections are described in the Club Magazine, which you receive free each month.

You may accept the monthly selection for your Division . . . take any of the other records offered (classical or popular) . . . or take NO record in any particular month.

Your only membership obligation is to purchase six selections from the more than 150 Columbia and Epic records to be offered in the coming 12 months. You may discontinue your membership at any time thereafter.

The records you want are mailed and billed to you at the regular list price of $4.98 (Classical and Original Cast selections, $5.98), plus a small mailing and handling charge.

FREE BONUS RECORDS GIVEN REGULARLY: If you wish to continue as a member after purchasing six records, you will receive a Columbia or Epic stereo Bonus record of your choice free for every two selections you buy.

MAIL THE COUPON TODAY! Since the number of Beethoven Sets we can distribute on this special offer is limited — we sincerely urge you to mail the coupon at once.

ALSO AVAILABLE IN REGULAR HIGH FIDELITY!

If you have a standard phonograph, you may receive the regular high-fidelity version of this Deluxe Beethoven Set for only $5.98. The plan is exactly the same as outlined above — except that you join any one of the Club's four regular musical Divisions, and you pay only $3.98 (Popular) or $4.98 (Classical and Original Cast selections) for the regular high-fidelity records you accept. Check appropriate box in coupon.

MORE THAN 1,000,000 FAMILIES NOW ENJOY THE MUSIC PROGRAM OF

COLUMBIA RECORD CLUB TERRE HAUTE, IND.

SEND NO MONEY — Mail this coupon now to receive the 9 Beethoven Symphonies for only $5.98

COLUMBIA RECORD CLUB, Dept. 210-9
Terre Haute, Indiana

Please send me, at once, the Deluxe 7-Record Stereo Set of Beethoven Symphonies, for which I am to be billed only $5.98, plus a small mailing and handling charge. Enroll me in the following Division of the Club:

(check one box only)

☐ **Stereo Classical** ☐ **Stereo Popular**

I agree to purchase six selections from the more than 150 records to be offered during the coming 12 months, at regular list price plus small mailing and handling charge. If I decide to continue my membership, I am to receive a 12" Columbia or Epic stereo Bonus record of my choice FREE for every two additional selections I buy.

If you wish to receive your Beethoven Set in regular high-fidelity, check below the musical Division of your choice. You agree to purchase 6 selections from more than 150 regular high-fidelity records to be offered in the next 12 months.

☐ **Classical** ☐ **Popular** ☐ **Show Music** ☐ **Jazz**

Name..
(Please Print)

Address..

City..........................ZONE....State..................

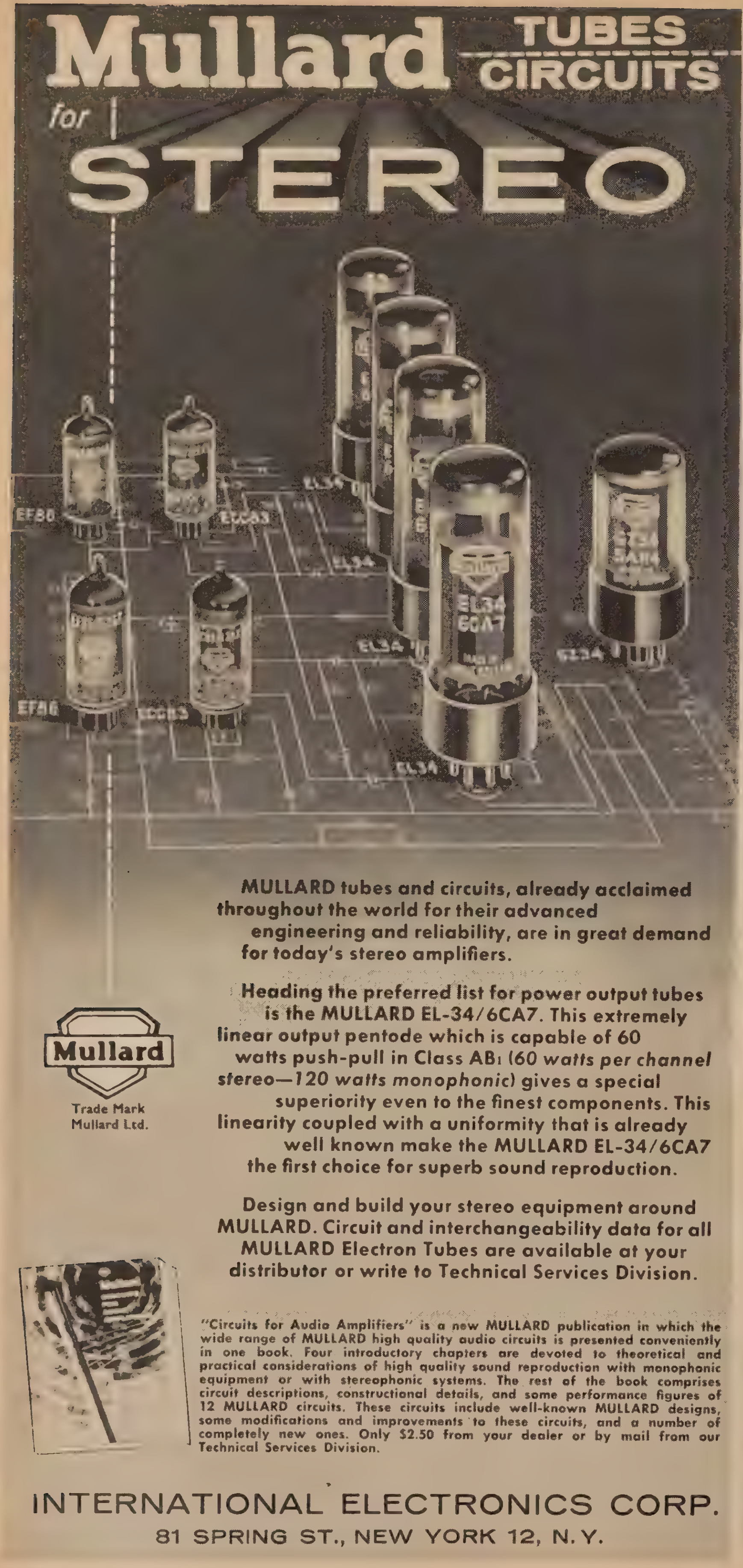
ALASKA and HAWAII: write for special membership plan
CANADA: address 1111 Leslie St., Don Mills, Ontario

If you want this membership credited to an established Columbia or Epic record dealer, authorized to accept subscriptions, fill in below:

Dealer's Name
and Address..59

B5-DA (STER) | B5-DG (REG)

® "Columbia," ⓟ, "Epic," Marcas Reg. © Columbia Records Sales Corp., 1960



Mullard TUBES CIRCUITS for STEREO

MULLARD tubes and circuits, already acclaimed throughout the world for their advanced engineering and reliability, are in great demand for today's stereo amplifiers.

Heading the preferred list for power output tubes is the MULLARD EL-34/6CA7. This extremely linear output pentode which is capable of 60 watts push-pull in Class AB₁ (*60 watts per channel stereo—120 watts monophonic*) gives a special superiority even to the finest components. This linearity coupled with a uniformity that is already well known make the MULLARD EL-34/6CA7 the first choice for superb sound reproduction.

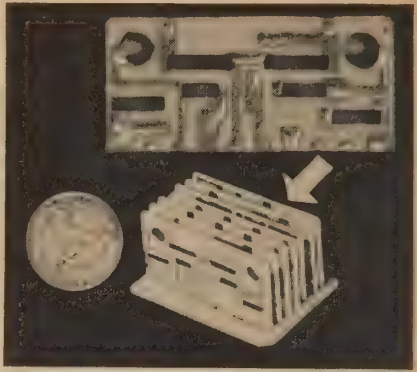
Mullard
Trade Mark
Mullard Ltd.

Design and build your stereo equipment around MULLARD. Circuit and interchangeability data for all MULLARD Electron Tubes are available at your distributor or write to Technical Services Division.

"Circuits for Audio Amplifiers" is a new MULLARD publication in which the wide range of MULLARD high quality audio circuits is presented conveniently in one book. Four introductory chapters are devoted to theoretical and practical considerations of high quality sound reproduction with monophonic equipment or with stereophonic systems. The rest of the book comprises circuit descriptions, constructional details, and some performance figures of 12 MULLARD circuits. These circuits include well-known MULLARD designs, some modifications and improvements to these circuits, and a number of completely new ones. Only $2.50 from your dealer or by mail from our Technical Services Division.

INTERNATIONAL ELECTRONICS CORP.
81 SPRING ST., NEW YORK 12, N.Y.

NEWS BRIEFS *(Continued from page 10)*



price comparable with standard versions.

Two advanced types of capacitors now in production—Cerafil and Cerol—were also shown. Both are ceramics and are made in a way that makes great size reduction possible.

To make a Cerafil capacitor, Aerovox starts off with a ceramic tube about 1/32 inch in diameter. The tube's outer surface is metallized, and the metallized layer acts as one of the electrodes. Over the metallized surface, a thin film of ceramic dielectric is formed and over the dielectric goes another metallized layer for the other electrode. A single finished tube or a parallel combination makes up the finished unit, depending on its capacitance. Leads, protective coating and color coding are the final steps.

The Cerafil line covers values from 10 μμf to 0.1 μf. Up through the .001-μf units, they measure .090 inch in diameter and 0.320 inch long. The 0.1-μf units are 0.310-inch diameter and 0.750 inch long.

As it is not practical to make Cerafil capacitors larger than 0.1 μf at this time, Aerovox has developed a rolled type ceramic-dielectric capacitor for the larger capacitance values of 0.1 μf–2 μf. The 0.1-μf capacitors are 0.210 inch in diameter and 0.690 inch in length, and the 2-μf units are 0.400 inch in diameter and 1.44 inches long. All Cerafil and Cerol units are rated at 100 volts at 85°C.

USSR SPACE TIMETABLE may be far ahead of ours, Dr. Eberhardt Rechtin, telecommunications chief of the Jet Propulsion Laboratory, said in a speech in which he also declared that continuing space programs at their present level is largely a waste of money.

According to Dr. Rechtin, Soviet space scientists have presented a plan under which a Soviet satellite carrying two men will, within the next few months, orbit the earth for 2 weeks, and shortly afterward two men with a television camera will make a round trip to the moon. This may be followed by another rocket in which two men and two women will make a trip around the moon lasting a half-year. In 1961, Soviet scientists expect to send rockets to Mars and Venus.

(Continued on page 18)

F.C.C. COMMERCIAL OPERATOR LICENSE

Training... for Jobs in Electronics

F.C.C. LICENSE—THE KEY TO BETTER JOBS

An F.C.C. *commercial* (not amateur) license is your ticket to higher pay and more interesting employment. This license is Federal Government evidence of your qualifications in electronics. Employers are eager to hire *licensed* technicians.

WHICH LICENSE FOR WHICH JOB?

The THIRD CLASS radiotelephone license is of value primarily in that it qualifies you to take the second class examination. The scope of authority covered by a third class license is extremely limited.

The SECOND CLASS radiotelephone license qualifies you to install, maintain and operate most all radiotelephone equipment except commercial broadcast station equipment.

The FIRST CLASS radiotelephone license qualifies you to install, maintain and operate every type of radiotelephone equipment (except amateur) including all radio and television stations in the United States, its territories and possessions. This is the highest class of radiotelephone license available.

GRANTHAM TRAINING PREPARES YOU

The Grantham Communications Electronics Course prepares you for a *FIRST CLASS* F.C.C. license, and it does this by TEACHING you electronics. Each point is covered simply and in detail, with emphasis on making the subject easy to understand. The organization of the subject matter is such that you progress, step-by-step, to your specific objective—a first class F.C.C. license.

CORRESPONDENCE OR RESIDENCE CLASSES

Grantham training is offered by correspondence or in resident classes. Either way, we train you quickly and thoroughly—teach you a great deal of electronics and prepare you to pass the F.C.C. examination for a *first class* license. Your first class F.C.C. license is the quick, easy way to prove to your employer that you are worth more money.

Our training (either in resident classes or by correspondence) prepares you for a first class F.C.C. license in as little at 12 weeks. Most of our *correspondence* students take longer than 12 weeks to finish the course and get their first class licenses, but most of our full-time *resident* students get their first class licenses in 12 weeks or less. If you are a beginner in electronics, this F.C.C. license plus the electronic theory we teach you will qualify you for certain types of employment, and you can improve your practical ability while on the job earning a salary. On the other hand, if you already have practical experience, the Grantham course can add a thorough knowledge of theory and an F.C.C. license to that practical experience—a most important step in qualifying you for higher pay and greater job security.

Our free booklet gives details of how you can prepare quickly for a better job in the rapidly expanding electronics industry. Clip the coupon below and mail it to the Grantham School nearest you.

FOUR COMPLETE SCHOOLS: *To better serve our many students throughout the entire country, Grantham School of Electronics maintains four complete Divisions—located in Hollywood, Calif., Seattle, Wash., Kansas City, Mo., and Washington, D.C. All Divisions of Grantham School of Electronics offer the same rapid courses in F.C.C. license preparation, either by home study or in resident classes.*

Get your First Class Commercial F.C.C. License in 12 weeks by training at

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1505 N. Western Ave.
Hollywood 27, Calif.
(Phone: HO 7-7727)

SEATTLE
WASH.
408 Marion Street
Seattle 4, Wash.
(Phone: MA 2-7227)

KANSAS CITY
MO.
3123 Gillham Road
Kansas City 9, Mo.
(Phone: JE 1-6320)

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D. C.
821-19th Street, N. W.
Washington 6, D. C.
(Phone: ST 3-3614)

for FREE Booklet CLIP COUPON and mail in envelope or paste on postal card.

MAIL COUPON NOW

To: GRANTHAM SCHOOL OF ELECTRONICS

1505 N. Western
Hollywood
• 408 Marion
Seattle
• 3123 Gillham Rd.
Kansas City
• 821-19th, NW
Washington

Please send me your free booklet telling how I can get my commercial F. C. C. license quickly. I understand there is no obligation and no salesman will call.

Name____________________Age_____

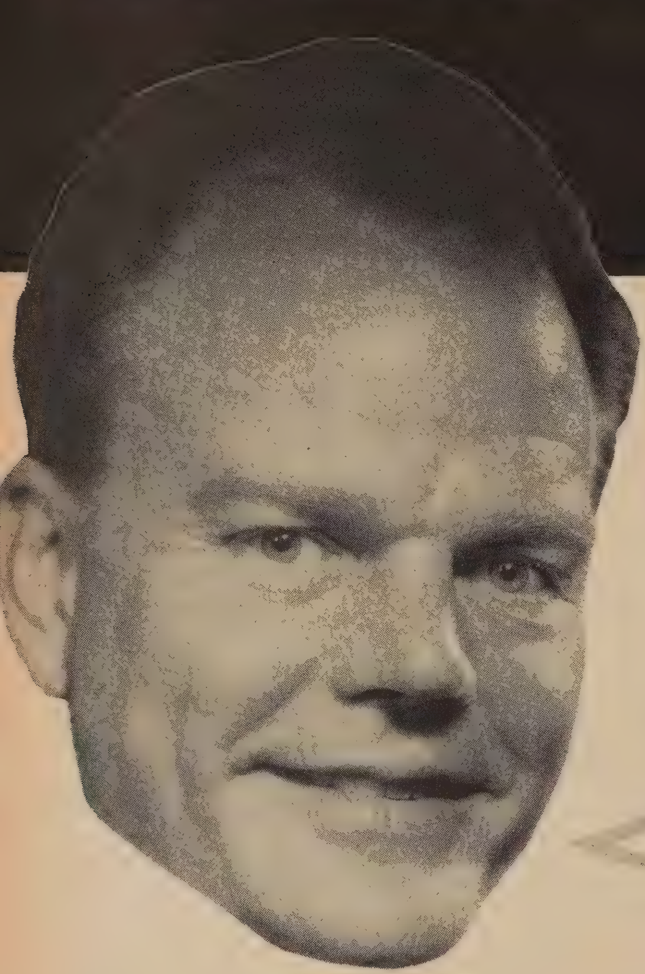
Address__________________________

City________________State________

I am interested in: ☐ Home Study, ☐ Resident Classes

04-B

WINEGARD Antenna Dealers to Make 1960

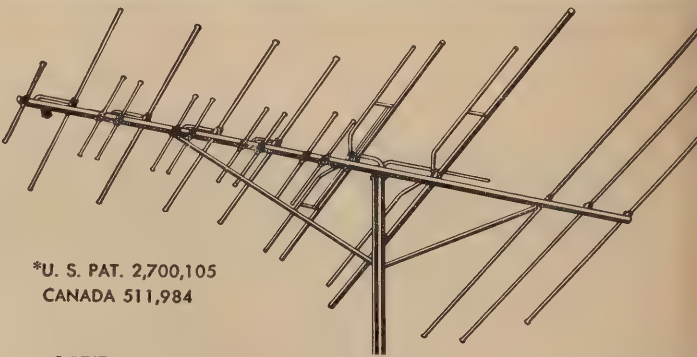


Tune in Paul Harvey News, ABC Network, Monday through Friday 5:55 E.S.T., starting January 18. (Check local listings for time and station.)

PAUL HARVEY

Sells Winegard Gold Color'Ceptor Antennas on National ABC Radio Network

"I'll be telling your customers why the Winegard Gold Color'Ceptor TV antenna is America's best antenna buy. I suggest you stock up on Color'Ceptors now to take advantage of Winegard's advertising and make more profit in 1960."



*U. S. PAT. 2,700,105
CANADA 511,984

Profit with the Antenna Dealers have learned to trust

Winegard dealers make more money for three important reasons—

1. They have the best performing, easiest to install, best constructed and neatest looking antenna on the market in the Winegard Gold Color'Ceptor.
2. They have the only *written* Performance Guarantee in the industry that guarantees 100% customer satisfaction or full list price of antenna refunded by Winegard—and the dealer still keeps his profit.
3. They get the antenna industry's biggest advertising backing.

Three Color'Ceptor models meet all needs: CL-4, $29.95; SCL-4, $38.95; CL-4X (with power pack) $44.90

Winegard Gold Anodizing

Winegard's special 7 cycle bright gold anodizing inside and out (not a cheap flash finish) hardens the antenna surface, seals out corrosion and weathering, exceeds U.S. Gov't specifications in salt spray tests.

Winegard performance is protected by U.S. *patents, confirmed by leading consumer researchers, by millions of happy users, by prospering dealers everywhere. First with the advancements the public wants and sales-minded dealers can sell! Feature the leader and be one!

Get Biggest Ad Backing
Biggest Profit Year Ever!

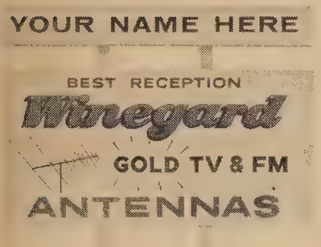
NOT here today and gone tomorrow . . . but ALL YEAR LONG!

Big Winegard Gold Color'Ceptor ads in the biggest consumer magazines . . . Paul Harvey on Network Radio . . . The Antenna Industry's biggest and most helpful advertising keeps hammering away, stronger and better than ever!

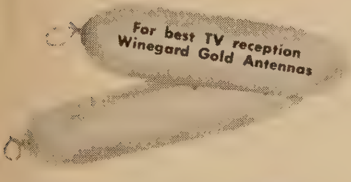
LIFE
FARM JOURNAL
Better Homes and Gardens
high fidelity
Successful Farming

DEALER SALES HELPS

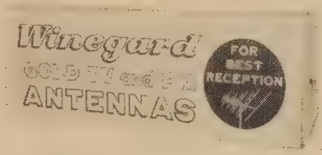
to connect Winegard's ad powerhouse to your cash register. To use in your store, outside your store, and out where the sales begin. Get these sales helps (delivery prepaid) with FREE "PROMOTION BUCKS". One "Buck" goes with each Color'Ceptor you order. Use your "Bucks" to get the sales helps that will do *you* the most good.


YOUR NAME HERE
BEST RECEPTION
Winegard
GOLD TV & FM
ANTENNAS

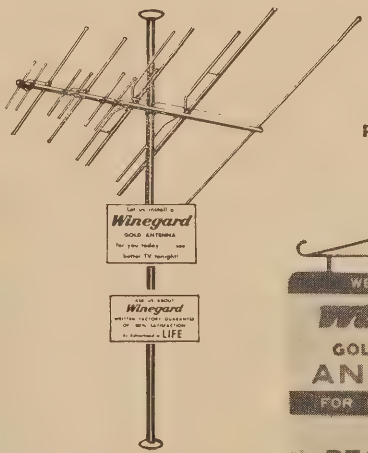
Giant 6-ft. 3-color metal road sign . . . with your name on it.


For best TV reception
Winegard Gold Antennas

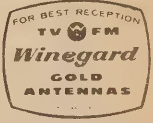
Balloons—With Winegard selling message—


Winegard
GOLD TV and FM
ANTENNAS
FOR BEST RECEPTION

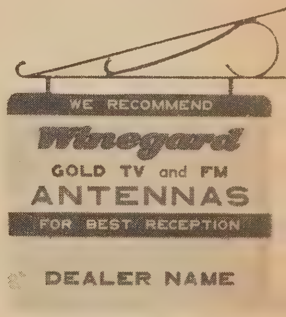
Illuminated window and counter sign.


Let us install a Winegard GOLD ANTENNA for you today ... see better TV tonight!
Ask us about Winegard written factory guarantee of 100% satisfaction As Advertised in LIFE

Gold anodized telescopic antenna display mast.


FOR BEST RECEPTION
TV FM
Winegard
GOLD
ANTENNAS

Truck decals, pressure-sensitive No water.


WE RECOMMEND
Winegard
GOLD TV and FM
ANTENNAS
FOR BEST RECEPTION
DEALER NAME

Metal outdoor store sign with hanger.

Winegard

ANTENNA SYSTEMS

WINEGARD CO. 3009-1 Scotten, Burlington, Iowa

WINEGARD CO.
3013-2 Scotten, Burlington, Iowa

☐ RUSH full color brochure showing Winegard's new antenna dealer sales aids . . . and tell me how I can get them free!

☐ Send literature on Winegard's complete line of FM and TV antennas.

NAME____________________

POSITION__________ FIRM__________

ADDRESS____________________

What's the latest score on cartridges?

☑	1ST	ceramic cartridge was invented by Sonotone...
☑	13	years ago. Today, over...
☑	65	different manufacturers have specified Sonotone for...
☑	662	models of high-quality phonographs. Altogether over...
☑	9,000,000	Sonotone Ceramic Cartridges have been used for original and replacement purposes. ('Nuff said!)

Sonotone® CORP.

Electronic Applications Division, Dept. C2-20

ELMSFORD, NEW YORK

In Canada, contact Atlas Radio Corp., Ltd., Toronto

Leading makers of fine ceramic cartridges, speakers, microphones, electronic tubes.

NEWS BRIEFS *(Continued from page 14)*

A more hopeful note was struck by Noah Dietrich, head of the Houston Fearless Corp., who stated that America has shaken off its complacency because of recent Russian advances. He predicted that we will now entirely eclipse Russian advances in missiles and space.

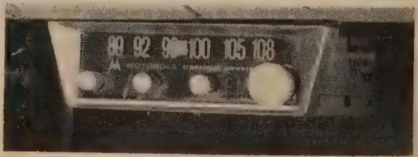
JACK BINNS, famed as the radio operator who sent the first radio distress signal to save a ship at sea (1909), died December 8, 1959, at the age of 75.

His CQD summoned aid to the sinking ship *Republic*, with the result that all 1,600 passengers and the crew were taken off the ship before it sunk.

Mr. Binns was born in England and worked for the Marconi Co. as a wireless operator for 7 years. He later was a reporter for the *New York American* and then worked on the staff of the *New York Tribune*. Joining the Hazeltine Corp. in 1924, he became president in 1942, chairman of the board in 1952 and, at the time of his death, was honorary chairman of the board.

ELECTRONIC LUNGS, HEART and other vital organs were seen by Gen. David Sarnoff in his crystal ball as replacements for damaged body parts. "Miniaturized electronic components," he thought, might eventually be developed "to serve as long-time replacement for organs that become defective through injury or age." He also predicted an electronic "dashboard"—a home device like the bathroom scale, which would "register heartbeats, blood pressure, pulse, with an alarm system," warning when to call the doctor.

FM CAR RADIO is now in production by Motorola. Designed for under-dash mounting in all 12-volt automobiles, the model FM-900 uses seven tubes, three transistors. Output is 15 watts push-pull. It works off regular AM car antenna, and includes afc.



FM car radios will also be offered by other makers, according to predictions by Standard Coil President J. O. Burke, "the industry is near a breakthrough on practical use of FM radios in automobiles." And Radio Condenser Corp. officials say that at least 6 manufacturers are considering production of FM car sets.

DR. OLIVER E. BUCKLEY, Bell Labs president and board chairman until his retirement in 1952, died Dec. 14 at the age of 72. Dr. Buckley was an outstanding scientist and administrator who also had served the US in numerous advisory capacities.

His early work included production and testing of power tubes for the first trans-Atlantic voice radio contact (1915) and research leading to laying of transoceanic phone cables to Europe, Hawaii and Alaska. He held 43 patents.

Among other honors he received were the Edison Medal of the American Institute of Electrical Engineers and this nation's highest civilian award, the Medal of Merit.

19-INCH TV TUBE with square corners, which will join its big brother 23-inch picture tube this year, is seen likely to replace a large share of the 17-inch market. The 19-inch screen will appear in portables, will also replace some lower-priced 21-inch sets using 114° deflection, it can work in 110° circuits.

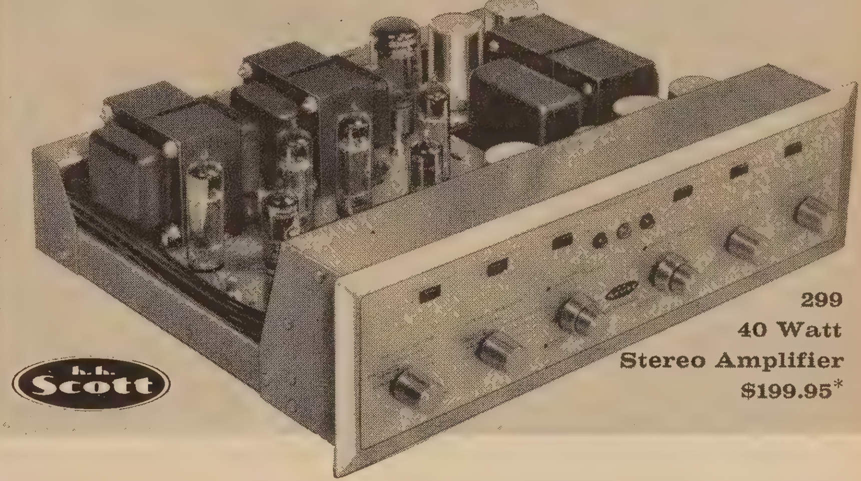
Added to set makers producing 23-inch sets were RCA, Zenith and Motorola. Previously using 23-inchers were Westinghouse, Admiral, Sylvania, Hoffman and others.

INTERNATIONAL Telecommunications Union (ITU) elected G. C. Gross of the US to be secretary general for next 3 years as it adjourned its once-every-10-years meeting which deals with radio spectrum allocations.

Prior to service with the ITU, Mr. Gross headed the FCC's International Technical Div.

NEW SEMICONDUCTOR material is gallium phosphide, which can operate at temperatures up to seven times as high as can silicon. The Signal Corps has made working diodes of the material which promises to solve some of the severe high-heat problems of guided missiles and space electronics. END

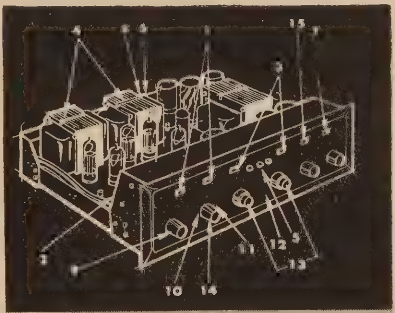
3 NEW STEREO AMPLIFIERS FROM H. H. SCOTT



299
40 Watt
Stereo Amplifier
$199.95*

Third Channel Output, Separate Tone Controls Make These The Most Versatile Amplifiers You Can Buy!

H. H. Scott's 299 Stereo Amplifier has been acclaimed "world's most versatile" by editors of all leading hi fi magazines. Like all H. H. Scott stereo amplifiers, it includes a third channel to give optimum realism in stereo playback and a signal for driving extension speak systems. Other advanced features include special balancing facilities and *separate* tone controls on each channel to let you adjust for tonal differences in speakers and room acoustics.

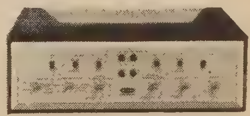


1. Provision for connecting two phono cartridges. **2.** D.C. Filament supply to virtually eliminate hum. **3.** Separate record scratch and rumble filters. **4.** Dual 20 watt power stages. **5.** Visual signal light panel. **6.** Stereo tape recorder output. **7.** Phase reverse switch. **8.** Third channel output. **9.** Compensation for direct connection of tape playback heads. **10.** Special switching to use your stereo pickup on monophonic records. **11.** Play a monophonic source through both channels simultaneously. **12.** Can be used as an electronic crossover. **13.** Completely separate Bass and Treble controls on each channel. **14.** Special balancing circuit. **15.** Loudness compensation. Specifications: Distortion (first order difference tone) less than 0.3%. Frequency Response: 20 cps to 30,000 cps. Harmonic Distortion: 0.8% at full power output. Noise and Hum: Hum better than 80db below full power output; noise equivalent to 10 microvolts on low level input.

222 24 Watt Stereo Amplifier

This budget priced stereo amplifier has such features as Third Channel Output and separate tone controls usually found only in much more expensive equipment. It is backed by H. H. Scott's reputation for quality and engineering leadership. $159.95*

130 Stereo Preamplifier



All the features of the 299 plus many more. Used where it is desired to separate heat producing power amplifiers from control location or where higher power is required than available in integrated amplifiers. $169.95*

*Slightly higher West of Rockies. Accessory case extra.

H. H. SCOTT

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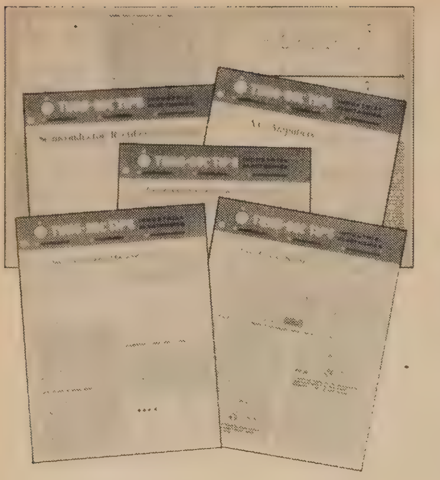

A Valuable Service for Industrial Servicemen—Free

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- Mobile Communications with a special issue devoted to single-side band operation.
- Induction Heating Systems.
- Temperature Control Systems.
- Weight Control and Batching.
- Closed Circuit Television.

And these are just a few of the many topics to be discussed in Tung-Sol's highly informative series.

With every issue you'll be building your own valuable storehouse of information designed specifically to give you the facts you need for your job. Write today asking to be put on the *Tung-Sol Tips* mailing list. Tung-Sol Electric Inc., Newark 4, New Jersey.

Back Issues

You can still get back issues of Tung-Sol Tips which you might have missed, including: (1) Semiconductor Rectifiers; (2) Gas-Filled Rectifiers; (3) Theory of Thyratron Operation; (4) Practical Applications of Thyratrons; (5) Photo-Electric Theory and Operations; (6) A. C. Amplifiers. Write and specify which you would like to receive.

TUNG-SOL®
ELECTRON TUBES • SEMICONDUCTORS

Correspondence

WANTS INDUSTRIAL TECHNICIANS

Dear Editor:

Regarding Lester Berry's letter on servicing industrial electronic equipment, our company is presently looking for qualified service organizations throughout the country to service our equipment.

We would like very much to hear from technicians and get their views and opinions on this sort of service.

We hope that you will continue your articles on industrial electronics equipment. These articles may stimulate service organizations into doing this kind of work.

RONALD WAGNER

Jordan Controls Co., Inc.
3235 W. Hampton Ave.
Milwaukee 9, Wis.

MICRO-INCH, NOT MICRON!

Dear Editor:

I have noticed that tape recorder manufacturers and magazines such as your own have been describing tape head gap widths in terms of "micron" when they mean micro-inch. For example, "90 microns" instead of .000090 inch, or 90 millionths of an inch.

A micron is a unit in the metric system, a millionth of a meter. Thus 90 microns equals 0.0035 inch; 120 microns would be .0047 inch—very sizable gaps! In other words, a micron is almost 40 times as big as a micro-inch!

All scientific work and measurements are based on the metric system, of which the micron is a part. Think what confusion would be wrought by the unthinking introduction of a new meaning for the term "micron"! Micro-inch is after all an economical term, and it does mean a millionth of an inch, which micron does not.

PHILIP N. BRIDGES

Rockville, Md.

INDUSTRIAL SERVICING

Dear Editor:

Lester Berry's letter in your December issue in regard to industrial service requires an answer.

There is no doubt that manufacturers of industrial electronic equipment sometimes shun the radio–TV service technician who inquires about servicing its equipment or asks for technical information.

The typical manufacturer of industrial electronic equipment is desperately looking for independent service operators to service the equipment he sells. However, because the public relations aren't all they should be (for the TV service industry) many of these manufacturers are afraid to turn over their customers to a TV service shop. It isn't that the fully informed feel that way, but the bad press the industry has received causes manufacturers to use extreme caution.

It has been established that manufacturers of industrial electronic equipment need independent service organizations, and that many TV service shop proprietors are interested in industrial business. The two must get together. The problem is a matter of adequate communication and lack of salesmanship. The manufacturer must be sold on the idea of a TV service shop being able to handle industrial servicing.

The service technician, looking for industrial service business, should put on a better front. Unfortunately, the manufacturer looks upon him as a tradesman in whipcords with no finesse in handling industrial customers. The service technician must wear his salesman's hat and sell the manufacturer on depending upon him so the manufacturer can in turn sell him to the customer with complete confidence.

There is no easy answer. But, the fact remains that the service technician and the equipment manufacturer need each other.

LEO G. SANDS

Ridgewood, N. J.

RESEARCH INFORMATION CENTERS

Dear Editor:

I read your editorial "Millions of Electronic Facts" (December, 1959, page 27) with interest and would like to add to it. For 14 years I have applied considerable study and research to the problem of information centers.

The principal factor preventing establishment of centers such as you advocate is that there is a considerable amount of time and expense required in setting up such a program, during which no benefits can be expected. Management in general has therefore turned thumbs down on these projects. This may seem short-sighted, but since the program would not bolster profits during its initial stages, this attitude is justified from a practical viewpoint.

The crux of the development has been an automated cross-reference indexing system. As an individual worker in the field, I have found the most frustrating factor to be the lack of funds to demonstrate the complete system.

An example of the advances to be expected with this system:

Just 3 typist-operators could process 1,780 cross-referenced abstracts a day. Present systems require 24 typists, plus several file clerks. This would take care of the roughly 240 important electronic English-language journals presently published monthly. Such cross-referenced abstracts would be in form to be filed by machine or by any other method.

I believe that this is one of the more

(*Continued on page* 26)

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NOW – Just $6 Starts You Training in RADIO-TELEVISION the SPRAYBERRY "Learn-by-Doing" Way . . .

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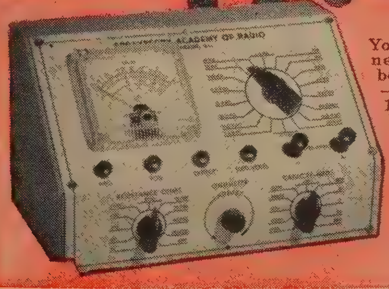
- You build this powerful two-band superheterodyne radio receiver.

Big New CATALOG AND Sample Lesson FREE!



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★ ★ ★ ★ This great industry is begging for trained men . . . to step into good paying jobs or a profitable business of their own! Our new plan opens the doors of Radio-Television wide to every ambitious man who is ready to act at once!

Men by the thousands... trained Radio-Television Service Technicians...are needed at once! Perhaps you've thought about entering this interesting, top paying field, but lack of ready money held you back. Now—*just $6 enrolls you* for America's finest, most up to date home study training in Radio-Television! Unbelievable? No, the explanation is simple! We believe Radio-Television *must* have the additional men it needs as quickly as possible. We are willing to do our part by making Sprayberry Training available for less money down and on easier terms than ever before. This is your big opportunity to get the training you need...to step into a fine job or your own Radio-Television Service Business.

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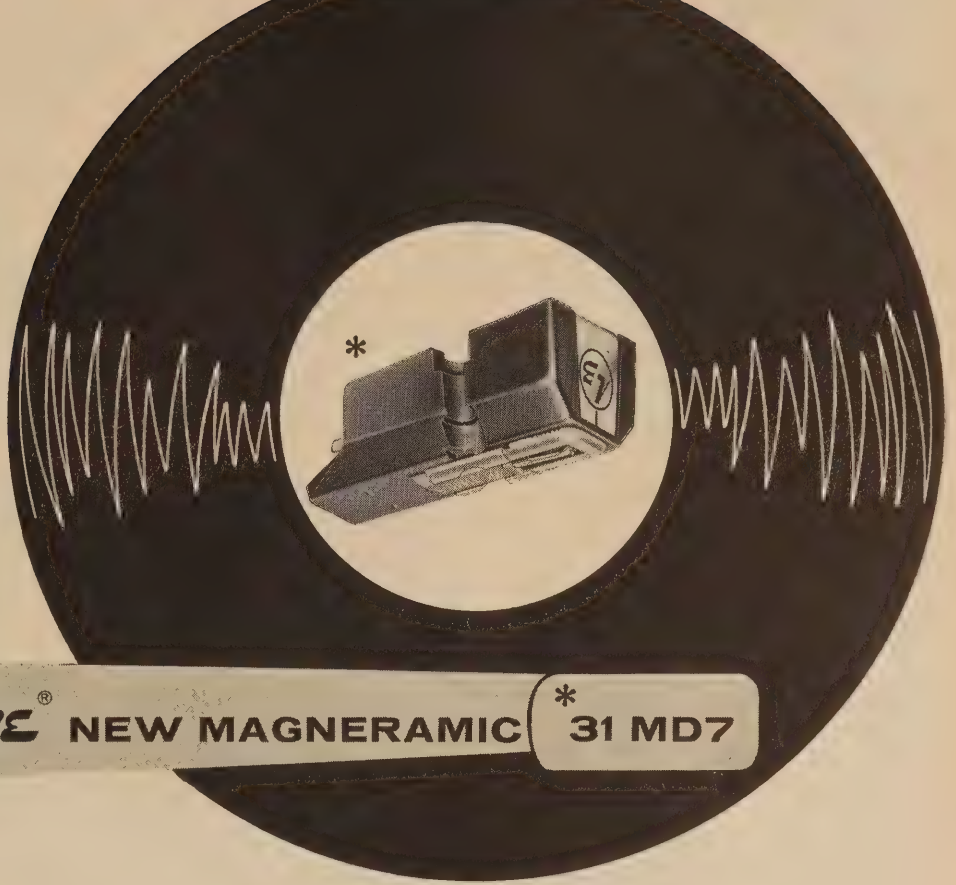
DELCO
RADIO

DELCO ELECTRONICS TRAINING SCHOOL SCHEDULE

DATE	REGION 1	REGION 2	REGION 3	REGION 4	REGION 5	REGION 6
1-11	Philadelphia	New Orleans	Chicago			
1-18				St. Louis	Dallas	Salt Lake City
1-25		Atlanta	Detroit			
2-1	Union					
2-8				Omaha	Memphis	
2-15	Pittsburgh	Jacksonville				Los Angeles
2-22	Pittsburgh		Cincinnati			
2-29				Kansas City		
3-7	Tarrytown	Charlotte		Kansas City	Dallas	Portland
3-14			Cleveland			
3-21				Omaha	El Paso	
3-28	Boston	Atlanta				Los Angeles
4-4	Boston		Chicago	Minneapolis		
4-11				Minneapolis	Houston	
4-18	Union	Washington	Milwaukee		Houston	San Francisco
4-25		Washington				
5-2			Cincinnati	Omaha		Portland
5-9	Buffalo				Okla. City	
5-16		Atlanta	Detroit	St. Louis		
5-23						Los Angeles
6-6	Tarrytown		Chicago		Dallas	
6-13		New Orleans				San Francisco
6-20	Philadelphia			Denver		
6-27			Cleveland		Memphis	Salt Lake City

why the most advanced professional cartridge…



Electro-Voice® NEW MAGNERAMIC *31 MD7

has ceramic elements!

For more than 35 years, Electro-Voice has been a leader in the development and manufacture of dynamic microphones and loudspeakers. Why then, with this extensive experience in designing and producing electro-magnetic devices, is Electro-Voice introducing the new Magneramic 31 Series stereo cartridge using ceramic elements?

The reason is that Electro-Voice is genuinely convinced that a precision ceramic cartridge is the finest type that can be made today . . . definitely superior to the magnetic type. The superiority of the Magneramic 31 is demonstrated in these three areas.

GREATER FLEXIBILITY — The 31 Series cartridge will operate perfectly at any stylus pressure from 2 to 20 grams. The same stylus assembly can be used for operation on both turntable and record changers; performance need not be compromised by using a special, stiff stylus assembly for record changers. Record wear is the only criterion in setting stylus pressure — cartridge operation is not affected. Thus, when converting from a changer to a turntable, or vice versa, replacement of the stylus assembly is not necessary when using the Magneramic 31.

HIGHER OUTPUT — Along with the trend toward less efficient speaker systems, more amplifier power has become a necessity. While most stereo amplifiers are now designed with input sensitivities to match the typical 5-millivolt output of magnetic stereo cartridges, nearly all monaural amplifiers were designed for at least 8-millivolt input. These cannot be driven to full output with a magnetic stereo cartridge. The Magneramic 31 develops a full 8-millivolt output and couples directly into any "magnetic" preamp unit. This higher output should especially be considered by those planning conversion to stereo utilizing existent monaural amplifiers.

FREEDOM FROM HUM — The increased amplifier gain required to satisfactorily drive low-efficiency speakers coupled with decreased cartridge output has significantly increased system hum problems. Also, conventional methods of hum elimination used in monaural magnetic cartridges become difficult or impossible to apply to stereo magnetics. The Magneramic 31 completely eliminates these problems — it is non-inductive and has adequate output.

The Electro-Voice Magneramic 31 MD7 cartridge directly replaces any monophonic or stereophonic magnetic cartridge now on the market. It feeds into the preamp input-jack specified for magnetic cartridges and does not require adaptors or circuit modifications.

SPECIFICATIONS — MAGNERAMIC 31 MD7

Response Range: 20 to 15,000 cps ± 2 db
Compliance, Vertical: 3.5 x 10^{-6} cm/dyne
Compliance, Lateral: 3.5 x 10^{-6} cm/dyne
Isolation: 28 db @ 1000 cycles
Tracking Force: 2 to 4 grams in transcription arms
4 to 6 grams in changer arms
Styli: .7 mil diamond
Output: 8 millivolts
Recommended Load: 22,000 to 47,000 ohms
(Magnetic phono inputs)
Elements: 2, Lead Zirconium Titanate (Ceramic)
Weight: 8 grams
Terminals: 4, standard .050″ connectors
Mounting Centers: ½″ and 7/16″ fits both
Audiophile Net: $24.00

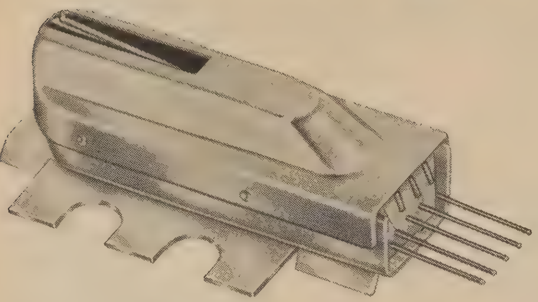
Want more information? Write to Dept. 20E for the booklet entitled, "FACTS ABOUT THE ELECTRO-VOICE MAGNERAMIC CARTRIDGE"

Electro-Voice® INC.
BUCHANAN, MICHIGAN

WEATHERS STEREO COMPONENTS

combine **HIGH QUALITY REPRODUCTION** *and*

low record wear



WEATHERS
StereoRamic
Cartridge C-501

SPECIFICATIONS

Frequency Response	20-30,000 cps
Compliance	10×10^{6} cm/dyne
Dynamic Moving Mass	1.0 milligrams
Tracking Force	1-2 grams—Professional arms 2-6 grams—Changers and other type arms
Stylus	0.7 mil diamond or sapphire
Separation	25 db
Signal-to-noise Ratio	—60 db
Output per channel	15 millivolts into magnetic input

Audiophile Net

C-501-D—Diamond	**$17.50**
C-501-S—Sapphire	**$ 9.75**

A new achievement in ceramic cartridge performance . . . advance-designed for use in changers and other tonearms. Weathers ceramic cartridge does not fight with record grooves. Its effortless, smooth-treading performance means less wear for your records. There is a complete lack of needle talk and chatter, made possible through the use of Weathers Ring Filter Technique—the most efficient means of securing separation between channels . . . better than 25 db. Shielded, too, against hum. Weathers StereoRamic Cartridge comes fully wired and ready for use.

balance

Weathers Tonearm MT-5
is balanced perfectly . . .
so accurate that
turntable leveling
is unnecessary!

The Weathers Micro-Touch Stereo Tonearm is designed exclusively for Weathers StereoRamic Cartridge and is an exact duplicate of the arm created for the famous FM 1-gram system. This 1-gram tracking force assures low record wear. Shock mounting isolates the tonearm resonance down to 15 cps. Superbly constructed for cueing ease. Made of the finest basswood which gives maximum strength with minimum weight. Comes complete with stereo leads.

SPECIFICATIONS

Arm Bearing System	Viscous Damping
Tracking Force	Easily adjusted 1 to 8 grams
Finish	Ebony with gold trim
Overall length	13 inches
Pivot to Stylus Tip Length	9¾ inches
Recommended Overhang	½ inch

Audiophile Net **$38.50**

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CORRESPONDENCE *(Continued from p. 22)*

important advances available to research engineering. It is not being utilized, and does not appear likely to be adopted in our lifetime.

C. A. PRITCHARD
Arlington, Va.

INDUSTRIAL ELECTRONICS CIRCUITS

Dear Editor:

I am very glad to see an industrial section in RADIO-ELECTRONICS Magazine, especially the article on relays by Alvin G. Sydnor ("Relays in Industry," November, 1959, page 52).

There is a very great need for a magazine on industrial circuits of all kinds.

HAROLD MALE
New Westminster
British Columbia

INDUSTRIAL INFORMATION

Dear Editor:

I am interested to see you are starting an industrial electronics section. Two years ago I saw an article on how to build a color organ which used thyratrons to operate lights corresponding to treble, mid-range and bass. Later I improved on this, with an experimental unit of 8 channels, which I expanded to 10, then 20 and finally 30. When I went into stereo, I divided the channels into 15 per speaker, so I now have a stereo color organ.

What I am working up to is that I knew little about thyratrons and had to study up on them. I got very little information. I found books that gave circuits for arc welders, etc., but seldom went into lighting circuits, especially theater lighting and dimming, which depend on this principle. I also noticed references to magnetic amplifiers and, though the principles were explained, it seems that no practical circuits with practical values are given. For example, I can imagine an article on building a theater switchboard would be of interest to people working in little-theater groups throughout the country.

DON F. HILL
Los Angeles, Calif.

(It is very definitely our intention to describe actual equipment rather than abstract circuitry in our industrial electronics articles.—*Editor*)

FAN MAIL

Dear Editor:

For a long time I have been buying your magazine at newsstands every time I saw an interesting article.

RADIO-ELECTRONICS has been so interesting the last three issues that I have decided to be one of your permanent subscribers, and I will, if you continue to keep the magazine loaded with up-to-date information on new gadgets and developments in the electronics field.

Best wishes for continued success.

JESUS M. MALDONADO
Bradenton, Fla. END

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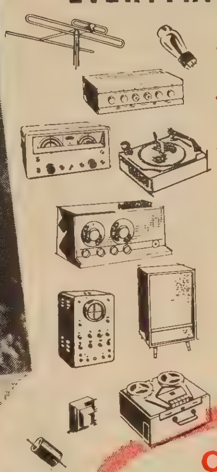
EVERYTHING IN ELECTRONICS



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How far can you go in electronics without a degree?

How far can you go in electronics . . .

Two years ago, Field Engineer William G. Miles was asked to outline *his* thinking on how far he could go in electronics at IBM . . . without a degree. Now, he reviews the progress he's since made. His present position: Group Manager, responsible for keeping one of America's largest electronic computers in top operating condition. Here's his story.

HURDLING THE DEGREE BARRIER. "A few years ago," recalls Bill Miles, "I felt that I'd gone about as far as a technician could without a degree. I just couldn't hurdle that education barrier. Now, thanks to IBM, I have a solid electronics education. I'm a Group Manager on the SAGE project, responsible for 20 field engineers. My future looks brighter than it ever did. I don't know of another company where a technician can go farther or receive more recognition, without a degree, than at IBM."

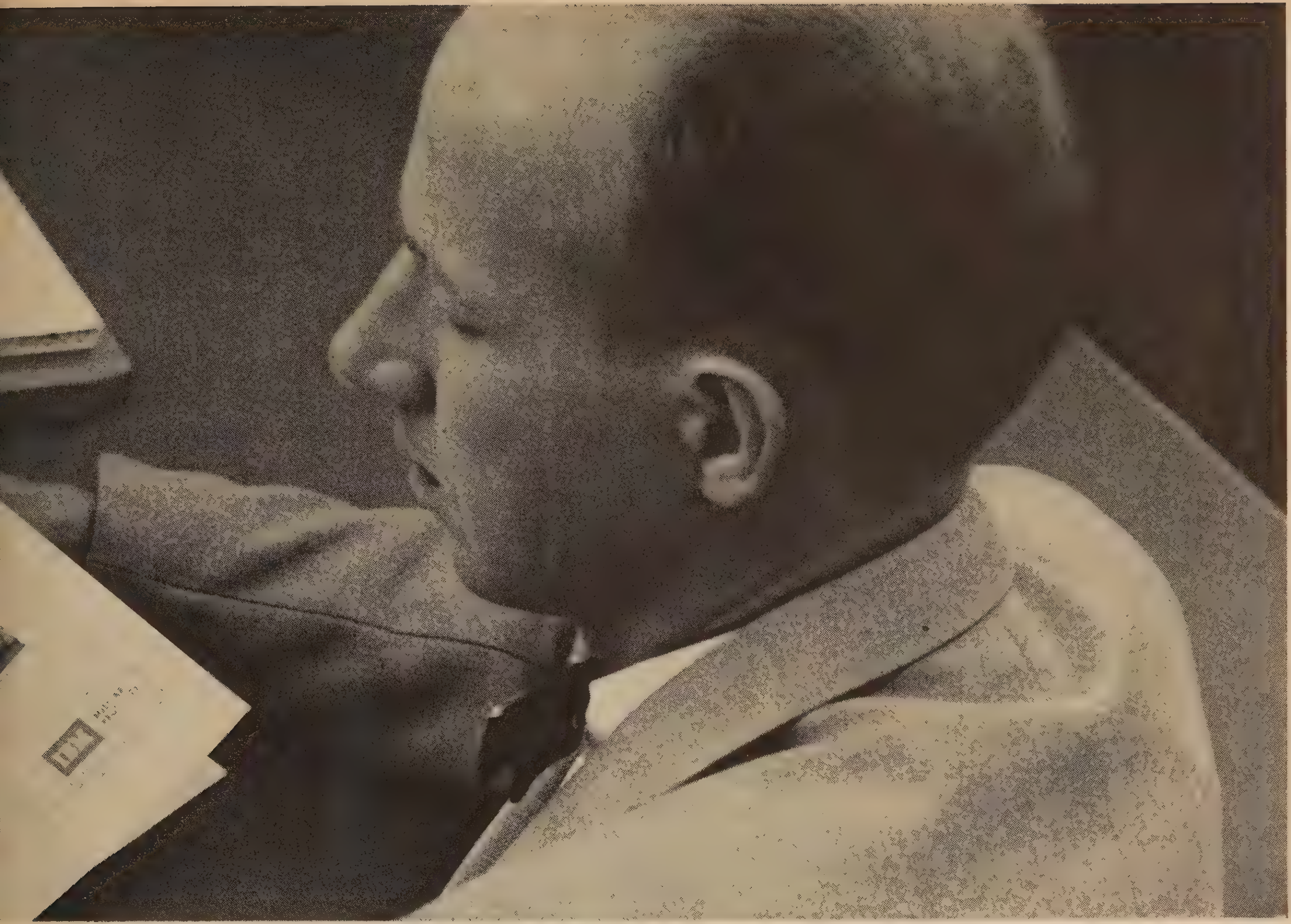
UTILIZING HIS NAVAL TRAINING. Bill Miles spent three years as a Naval Aviation Radar Technician. After discharge from service, he worked as a TV serviceman, at the same time pursuing an engineering education at night. "I knew there were good career opportunities around somewhere, but I couldn't find them," Bill Miles says. "I investigated several big companies. They were impressed with my ability, but my lack of a degree kept me from the kind of a career I wanted. Then I answered an ad similar to this."

EXTENSIVE ELECTRONICS SCHOOLING. In May, 1955, he joined IBM and began an extended training course. "The teaching was as technically advanced as I could ask for. Each day, I gained a deeper knowledge of electronics and added to my professional stature. IBM shows real interest in you as an individual: what your goals are, what plans you've made to reach your goals, how the company can help speed you toward them or even higher goals."

ASSIGNED TO SAGE SITE. After his training, Bill Miles was assigned to a SAGE site. SAGE is an important link in America's air defense, and the heart of SAGE is a real-time computer made by IBM. The SAGE computer analyzes radar data with uncanny accuracy, checks it against available air traffic information, and presents visual displays to assist the Air Force in identifying flying objects as friend or foe.

UPGRADING TECHNICIANS. "The job of IBM field engineers is to keep SAGE computers running," he explains. "This involves maintaining, testing, and checking computer units. It means anticipating trouble before it occurs. The work turned out to be exactly what I was looking for. I had a chance to do work ordinarily done by graduate engineers . . . work usually denied to men without a degree. Of all the companies I know, IBM appears to be one of the few which upgrades technicians to levels of engineering responsibility . . . levels dictated not by your formal education but by your native talents."

MANY EDUCATIONAL OPPORTUNITIES. "SAGE field engineers have many opportunities for education beyond the 'basic' training, which lasts 20 weeks," says Bill Miles. "After a year or two in the field, they may be selected for further training to learn how the complete SAGE electronic computer system works. To



Bill Miles reviews two-year-old article about his IBM career.

without a degree?

keep up with the most advanced electronic developments, they may also attend classes during working hours."

RAPID ADVANCE TO GROUP MANAGER. In his four years with IBM, Bill Miles has received several promotions. He is now Group Manager at a SAGE site. "My advancement is an example of IBM's policy of promoting from within," he says. "The company is quick to recognize a man's contributions and quick to reward him. This means lots of opportunities for new men who show potential for advancement along clearly defined routes—both in the technical and managerial areas. There are no limits set on your future. Everything IBM has ever promised about advancement in field engineering, I've seen happen—either to me or to someone I know."

* * *

If you have a minimum of 3 years' technical schooling after high school—or equivalent experience—you may be eligible for 20 weeks' training as a Computer Units Field Engineer. Starting salaries are based on your education and experience. While training you will also receive a living allowance.

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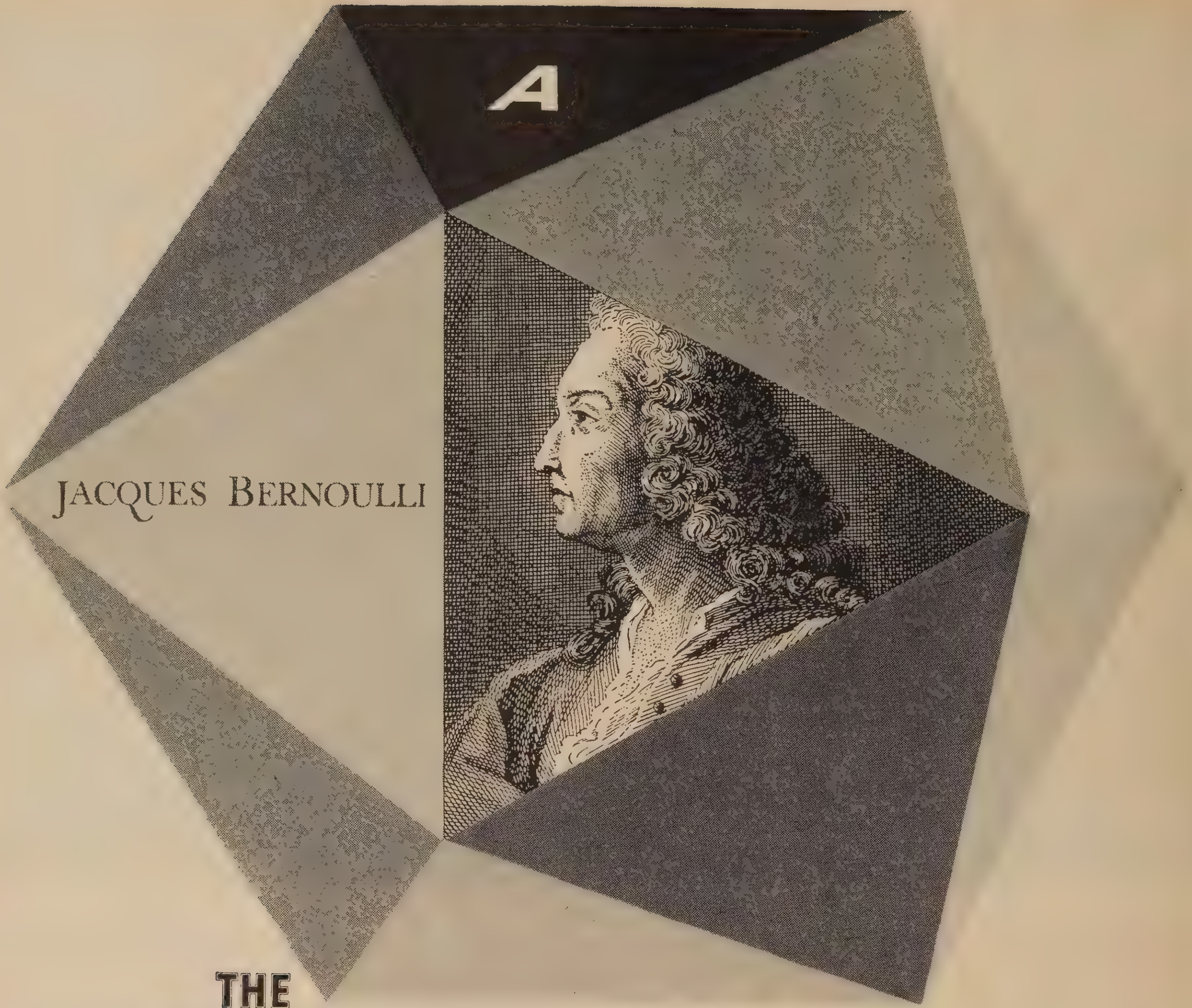

THE WIZARD OF ODDS

He solved a telephone traffic problem two centuries ago

Jacques Bernoulli, the great Swiss mathematician, pondered a question early in the 18th century. Can you mathematically predict what will happen when events of chance take place, as in throwing dice?

His answer was the classical Bernoulli binomial distribution—a basic formula in the mathematics of probability (published in 1713). The laws of probability say, for instance, that if you roll 150 icosahedrons (the 20-faced solid shown above), 15 or more of them will come to rest with side "A" on top only about once in a hundred times.

Identical laws of probability govern the calls coming into your local Bell Telephone exchange. Suppose you are one of a group of 150 telephone subscribers, each of whom makes a three-minute call during the busiest hour of the day. Since three minutes is one-twentieth of an hour, the probability that you or any other subscriber will be busy is 1 in 20, the same as the probability that side "A" of an icosahedron will be on top. The odds against 15 or more of you talking at once are again about 100 to 1. Thus it would be extravagant to supply your group with 150 trunk circuits when 15 are sufficient for good service.

Telephone engineers discovered at the turn of the century that telephone users obey Bernoulli's formula. At Bell Telephone Laboratories, mathematicians have developed the mathematics of probability into a tool of tremendous economic value. All over the Bell System, the mathematical approach helps provide the world's finest telephone service using the least possible equipment. The achievements of these mathematicians again illustrate how Bell Laboratories works to improve your telephone service.

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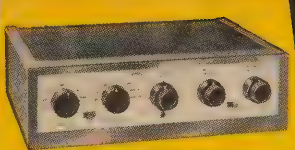
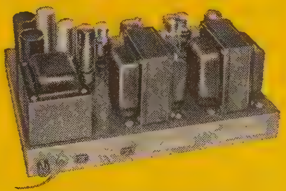
LEVEL
BASS
MODEL HF 81
TREBLE

Stereo Amplifier-Preamplifier HF81



Stereo Preamplifier HF85



70W Stereo Power Amplifier HF87
28W Stereo Power Amplifier HF86

FM Tuner HFT90
AM Tuner HFT94
FM/AM Tuner HFT 92

Stereo Integrated Amplifier AF4

12W Mono Integrated Amplifier HF12
Other Mono Integrated Amplifiers: 50, 30, & 20W (use 2 for stereo)

2-Way Bookshelf Speaker System HFS1
3-Way Speaker System HFS3
2-Way Speaker System HFS5

HF81 Stereo Amplifier-Preamplifier selects, amplifies, controls any stereo source & feeds it thru self-contained dual 14W amplifiers to a pair of speakers. Provides 28W monophonically. Ganged level controls, separate balance control, independent bass & treble controls for each channel. Identical Williamson-type, push-pull EL84 power amplifiers. **"Excellent"** — SATURDAY REVIEW; HI-FI MUSIC AT HOME. **"Outstanding quality . . . extremely versatile."**—ELECTRONICS WORLD LAB-TESTED. **Kit $69.95. Wired $109.95.** Includes cover.

HF85 Stereo Preamplifier is a complete, master stereo preamplifier-control unit, self-powered for flexibility & to avoid power-supply problems. Distortion borders on unmeasurable even at high output levels. Level, bass, & treble controls independent for each channel or ganged for both channels. Inputs for phono, tape head, mike, AM, FM, & FM-multiplex. One each auxiliary A & B input in each channel. Switched-in loudness compensator. **"Extreme flexibility . . . a bargain."**— HI-FI REVIEW. **Kit $39.95. Wired $64.95.** Includes cover.

New HF87 70-Watt Stereo Power Amplifier: Dual 35W power amplifiers of the highest quality. Uses top-quality output transformers for undistorted response across the entire audio range **at full power** to provide utmost clarity on full orchestra & organ. IM distortion 1% at 70W, harmonic distortion less than 1% from 20 to 20,000 cps within 1 db of 70W. Ultra-linear connected EL34 output stages & surgistor-protected silicon diode rectifier power supply. Selector switch chooses mono or stereo service; 4, 8, 16, and 32 ohm speaker taps, input level controls; basic sensitivity 0.38 volts. Without exaggeration, one of the very finest stereo amplifiers available regardless of price. Use with self-powered stereo preamplifier-control unit (HF85 recommended). **Kit $74.95. Wired $114.95.**

HF86 28W Stereo Power Amplifier **Kit $43.95. Wired $74.95.**

FM Tuner HFT90: Prewired, prealigned, temperature-compensated "front end" is drift-free. Prewired exclusive precision **eye-tronic**® traveling tuning indicator. Sensitivity: 1.5 uv for 20 db quieting; 2.5 uv for 30 db quieting, full limiting from 25 uv. IF bandwidth 260 kc at 6 db points. Both cathode follower & FM-multiplex stereo outputs, prevent obsolescence. Very low distortion. **"One of the best buys in high fidelity kits."** — AUDIOCRAFT. **Kit $39.95*. Wired $65.95*. Cover $3.95.** *Less cover, F.E.T. Incl.

New AM Tuner HFT94. Matches HFT90. Selects "hi-fi" wide (20c – 9kc @ —3 db) or weak-station narrow (20c–5kc @ —3 db) bandpass. Tuned RF stage for high selectivity & sensitivity; precision **eye-tronic**® tuning. **Kit $39.95. Wired $65.95.** Incl. Cover & F.E.T.

New FM/AM tuner HFT92 combines the renowned EICO HFT90 tuner with excellent AM tuning facilities. **Kit $59.95. Wired $94.95.** Includes covers and F.E.T.

New AF-4 Stereo Amplifier provides clean 4W per channel or 8W total output. Inputs for ceramic/crystal stereo pick-ups, AM-FM stereo, FM-multi stereo. 6-position stereo/mono selector. Clutch-concentric level & tone controls. Use with a pair of HFS-5 Speaker Systems for good quality, low-cost stereo. **Kit $38.95. Wired $64.95.**

HF12 Mono Integrated Amplifier provides complete "front-end" facilities and true high fidelity performance. Inputs for phono, tape head, TV, tuner and crystal/ceramic cartridge. Preferred variable crossover, feedback type tone control circuit. Highly stable Williamson-type power amplifier circuit. Power output: 12W continuous, 25W peak. **Kit $34.95. Wired $57.95.** Includes cover.

New HFS3 3-Way Speaker System Semi-Kit complete with factory-built ¾" veneered plywood (4 sides) cabinet. Bellows-suspension, full-inch excursion 12" woofer (22 cps res.), 8" mid-range speaker with high internal damping cone for smooth response, 3½" cone tweeter. 2¼ cu. ft. ducted-port enclosure. System Q of ½ for smoothest frequency & best transient response. 32-14,000 cps clean, useful response. 16 ohms impedance. HWD: 26½", 13⅞", 14⅜". Unfinished birch **$72.50.** Walnut, mahogany or teak **$87.50.**

New HFS5 2-Way Speaker System Semi-Kit complete with factory-built ¾" veneered plywood (4 sides) cabinet. Bellows-suspension, ⅝" excursion, 8" woofer (45 cps res.), & 3½" cone tweeter. 1¼ cu. ft. ducted-port enclosure. System Q of ½ for smoothest frequency & best transient response. 45-14,000 cps clean, useful response. HWD: 24", 12½", 10½". Unfinished birch **$47.50.** Walnut, mahogany or teak **$59.50.**

HFS1 Bookshelf Speaker System complete with factory-built cabinet. Jensen 8" woofer, matching Jensen compression-driver exponential horn tweeter. Smooth clean bass; crisp extended highs. 70-12,000 cps range. 8 ohms. HWD: 23" x 11" x 9". Price **$39.95.**

HFS2 Omni-Directional Speaker System (not illus.) HWD: 36", 15¼", 11½". **"Eminently musical"** — HIGH FIDELITY. **"Fine for stereo"** — MODERN HI-FI. Completely factory- built. Mahogany or walnut **$139.95.** Blond **$144.95.**

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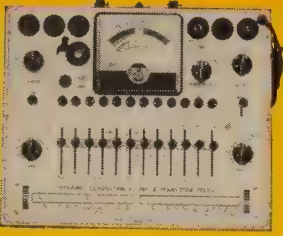

A

DYNAMIC CONDUCTANCE TUBE & TRANSISTOR TESTER #666
KIT $69.95 WIRED $109.95
Complete with steel cover & handle

B

TV-FM SWEEP GENERATOR AND MARKER #368
KIT $69.95 WIRED $119.95

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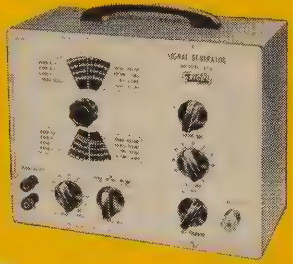

D

PEAK-TO-PEAK VTVM #232 & UNIPROBE (pat. pend)
KIT $29.95
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E

COLOR & MONOCHROME DC TO 5 MC LAB & TV 5″ OSCILLOSCOPE #460
KIT $79.95 WIRED $129.50

5″ PUSH-PULL Oscilloscope #425:
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A **Tests all receiving tubes** (picture tubes with adapter), n-p-n and p-n-p transistors. Composite indication of Gm, Gp & peak emission. Simultaneous selection of any one of 4 combinations of 3 plate voltages, 3 screen voltages, 3 ranges of continuously variable grid voltage (with 5% accurate pot.). Sensitive 200 ua meter. 10 six-position lever switches: freepoint connection of each tube pin. 10 pushbuttons: rapid insert of any tube element in leakage test circuit. Direct reading of inter-element leakage in ohms. New gear-driven rollchart. **CRA Adapter $4.50.**

B **Entirely electronic** sweep circuit with accurately-biased increductor for excellent linearity. Extremely flat RF output. Exceptional tuning accuracy. Hum and leakage eliminated. 5 fund. sweep ranges: 3-216 mc. Variable marker range: 2-75 mc in 3 fund. bands, 60-225 mc on harmonic band. 4.5 xtal marker osc., xtal supplied. Ext. marker provision. Attenuators: Marker Size, RF Fine, RF Coarse (4-step decade). Narrow range phasing control for accurate alignment.

C **150 kc to 435 mc with ONE generator** in 6 fund. bands and 1 harmonic band! ±1.5% freq. accuracy. Colpitts RF osc. directly plate-modulated by K-follower for improved mod. Variable depth of int. mod. 0-50% by 400 cps Colpitts osc. Variable gain ext. mod. amplifier: only 3.0 v needed for 30% mod. Turret-mounted, slug-tuned coils for max. accuracy. Fine and Coarse (3-step) RF attenuators. RF output 100,000 uv, AF output to 10 v.

D **Uni-Probe — exclusive with EICO — only 1** probe performs all functions: half-turn of probe tip selects DC or AC-Ohms. Calibration without removing from cabinet. Measure directly p-p voltage of complex & sine waves: 0-4, 14, 42, 140, 420, 1400, 4200. DC/RMS sine volts: 0-1.5, 5, 15, 50, 150, 500, 1500 (up to 30,000 v. with HVP probe, & 250 mc with PRF probe). Ohms: 0.2 ohms to 1000 megs. 4½″ meter, can't-burn-out circuit. 7 non-skip ranges on every function. Zero center.

E **Features DC amplifiers!** Flat from DC to 4.5 mc, usable to 10 mc. Vert. Sens.: 25 mv/in.; input Z 3 megs; direct-coupled & push-pull throughout. 4-step freq.-compensated attenuator up to 1000:1. Sweep: perfectly linear 10 cps — 100 kc (ext. cap. for range to 1 cps). Pre-set TV V & H positions. Auto sync. lim. & ampl. Direct or cap. coupling; bal. or unbal. inputs; edge-lit engraved lucite screen with dimmer control; plus many more outstanding features.

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Kit $29.95
Wired $49.95
Incl. F.E.T.; less 9V batt. Prealigned RF, IF xfmrs; push-pull audio; 6″ spkr.

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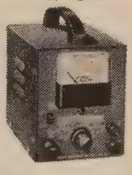

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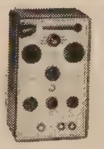
Wired $27.95



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Fast-checks radio/TV tubes, pilot lamps, etc.

Series/Parallel
R-C Combination Box #1140
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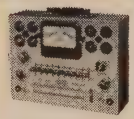

Tube Tester #625
Kit $34.95
Wired $49.95
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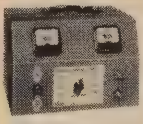
• illuminated roll-chart
Pix Tube Test Adapter....... $4.50



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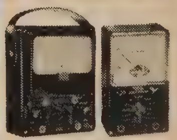

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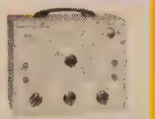

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Wired $29.95
Reads 0.5 ohms-500 megs, 10 mmfd-5000 mfd, power factor

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RF	$3.75	$4.95
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Radio-Electronics
Hugo Gernsback, Editor

MICROELECTRONICS

. . . A Major Revolution in Electronics Is Shaping . . .

EVER since the beginning of radio, and later the electronic art, components have steadily shrunk. We have reported its progress on this page at regular intervals.[*]

During the past few years, the shrinking of practically all electronic parts has accelerated at an unprecedented rate, so rapidly, in fact, that at this moment the art already has moved into *molecular electronics*—termed by some research laboratories *molectronics.*

RCA, General Electric, Westinghouse, Bell Laboratories, IBM, Texas Instruments are only a few of the pioneering researchers who are now deeply in *microelectronics,* a development that presages a revolution far greater than even the advent of the transistor.

To grasp this new advance fully, let us report that already the laboratories have components so small that they cannot be seen by the naked eye—they are truly of microscopic size! Nor do they look at all like the usual units. In fact, if the scientist who demonstrates the item to you did not assure you that the little speck you glimpsed under the microscope was a transistor or a capacitor or a resistor, you probably would not believe it. Yet such microcomponents are already facts today in the laboratory. By the mid-1960's, they will probably be for sale in civilian items, such as hearing aids, bio-electronic medical appliances and others. *Microradios,* considerably less than 1 inch square, will most likely appear by 1965 or earlier.

Why this frantic reduction in size? There are excellent reasons for it. First, economics—a huge shrinking in materials, in weight and, consequently, in cost, becomes possible. Second, and more important, in the coming microelectronics art, *practically all—if not all—soldering will have disappeared,* as an anachronism and technical barbarism. Hence, there will be little of the ancient disease of miscontacts or even worse, "intermittents" that have plagued manufacturers and service technicians for generations.

Third, and of vast importance: Military and coming space requirements are so stringent and so vital that large size and failures of components are matters of continuous threat to life. Hence they cannot be tolerated—there just cannot be a failure in future electronic gear.

In microelectronics, the reduction of size and weight, as well as other advantages—for instance, practically indestructible components that never wear out—will usher in a new age for the art.

What really is microelectronics? Stripped of most scientific and technical terms, it is the production and adaptation of microfilms so thin that they measure only one molecule thick.

We know the molecule is the smallest particle of matter that can exist by itself and still retain all the properties of the original element. That we really have to do with microscopic dimensions will be better appreciated when we realize that it takes nearly 1,000,000 films the thickness of one molecule to measure 1 inch thick![†]

Yet, unlikely as it sounds, it is possible to fashion capacitors, resistors and even transistors of single or multiple molecules, that behave exactly as their big brothers. It even becomes possible to build amplifiers and switching devices for computers that are so tiny that they can be seen only under a high-power microscope.

The microfilms that make this revolutionary art possible today are fashioned from either silicon or germanium, but it is certain that in the future other materials will be used as well. At present, there are various techniques—all more or less experimental—for fashioning the various components. Normally, the raw materials are sprayed, sputtered or evaporated in a high vacuum under considerable heat, as the first step. An insulating film, one or two molecules thick, may then be sprayed on; then the first step may be repeated. A few such steps will result in a workable microcapacitor. Resistors and transistors are created in similar fashion.

One may start with a metallic or insulating base, then build the component on top of it. The next required component can go right on top of the first one, depending upon the desired circuit. Or, if necessary, another component can be fashioned alongside the first one, and so forth.

The various components can readily be insulated from each other by spraying various amounts of oxygen, which then forms an oxide film on them. By proper manipulation, the components, whenever required, will be connected electrically with each other, either by direct contact or by sprayed metal film. Hence such sophisticated "microwiring" will no longer be the bothersome factor our present-day crude wiring or even printed circuits are.

It can be seen that in using these and other more refined techniques it becomes feasible to build complete radio chassis so tiny that hundreds of them can be placed in a single thimble!

It becomes clear now why such micro-assemblies are so rugged that they will be practically indestructible. Their minuscule size, and micro-weight, safeguards the structure against shock and mechanical stress. This is of utmost importance for military and space applications.

While such microelectronic assemblies can readily be connected and interconnected to other assemblies, they can also be electrically connected to their respective power supply.

Although batteries for portable electronic gear have steadily shrunk in size, chemical type dry cells probably will not be able to contract down to molecular size in the foreseeable future. And if they could, their power output would be so microscopic that they would never be able to drive even the smallest speaker for more than a few seconds.

Yet microbatteries with a serviceable electrical output are an early and foreseeable possibility. We speak of atomic batteries here. There is no difficulty in building them down to molecular size. Atomic batteries predicted by us in 1945 are a reality today. They are certain to be incorporated along with other components into self-powered microelectronic assemblies during the next 10 years.—*H.G.*

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[*] See "Midget Radio Sets," January, 1931; "Shrinking Radio," January, 1944; "Miniature Radios," September, 1944; "Microtubes," November, 1947; "Miniradios," November, 1953; "Minitelevision," August, 1956—and many others.

[†] The figure was based on the molecule of ordinary water (H_2O). Atoms of silicon and germanium have diameters in the order of one ten-millionth inch, and therefore would form much thinner films.

SINGLE CONTROL MULTIMETER

A unit without a zero control made possible by mercury batteries

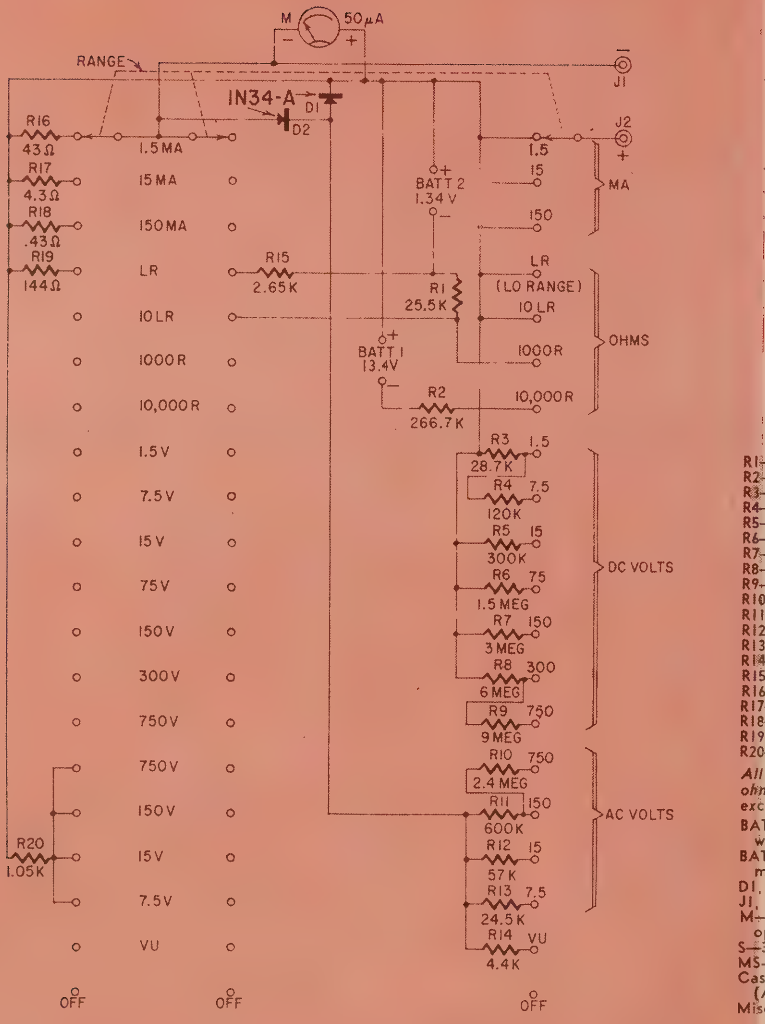
By ALBERT STRATMOEN

THE volt-ohm-milliammeter is the most universally used electronic test instrument. It is usually purchased ready-made or in kit form because the time involved in designing and constructing one is great enough to make it impractical. However, if one can get a meter movement for which the proper scales and design have been worked out, the project becomes practical.

This article describes the features and construction of a vom that should appeal to both the experienced man and the beginner. It has three features not found in commercial models:

- No zero-adjust control for the ohms section
- Maximum current in the ohms section limited to 500 μa
- The same linear scale for ac and dc ranges

Zero-adjust controls are needed in the ohms section of conventional instruments because the dry cells (carbon-zinc type) used as power sources are



M
50μA
RANGE
J1
J2
IN34-A
D1
D2
R16
43Ω
R17
4.3Ω
R18
.43Ω
R19
144Ω
1.5MA
15MA
150MA
LR
10LR
1000R
10,000R
1.5V
7.5V
15V
75V
150V
300V
750V
750V
150V
15V
7.5V
VU
R20
1.05K
OFF
OFF
OFF
BATT 2
1.34V
R15
2.65K
R1
25.5K
BATT 1
13.4V
R2
266.7K
1.5
15
150
MA
LR
(LO RANGE)
10LR
1000R
10,000R
OHMS
R3
28.7K
1.5
R4
120K
7.5
R5
300K
15
R6
1.5 MEG
75
R7
3 MEG
150
R8
6 MEG
300
R9
9 MEG
750
DC VOLTS
R10
2.4 MEG
750
R11
600K
150
R12
57K
15
R13
24.5K
7.5
R14
4.4K
VU
AC VOLTS

Circuit of the 1-control unit

R1—25,500 ohms
R2—266,700 ohms
R3—28,700 ohms
R4—120,000 ohms, deposited carbon
R5—300,000 ohms, deposited carbon
R6—1.5 megohms, deposited carbon
R7—3 megohms, deposited carbon
R8—6 megohms, deposited carbon
R9—9 megohms, deposited carbon
R10—2.4 megohms, deposited carbon
R11—600,000 ohms, deposited carbon
R12—57,000 ohms
R13—24,500 ohms
R14—4,400 ohms
R15—2,650 ohms
R16—43 ohms
R17—4.3 ohms, wirewound
R18—0.43 ohms, wirewound
R19—144 ohms
R20—1,050 ohms

All resistors ½ watt—10% units are selected with ohmmeter or resistance bridge to within 1% or better except for deposited-carbon and wirewound units

BATT 1—13.4 volts (Two Mallory TR-136R's in series with 1 cell removed from each)
BATT 2—1.34 volts (1 cell of Mallory TR-136R—removed from BATT 1)
D1, 2—1N34-A
J1, 2—insulated banana jacks
M—meter, 50 μa, 4½-inch scale (Precise Development M-50 or equivalent)
S—3-deck 3-pole 20-position nonshorting rotary (JBT MS-20-3 or equivalent)
Case, bakelite 6 13/16 x 5 9/16 x 2 5/16" with panel (Allied Radio 86P287 and 86P289 or equivalent)
Miscellaneous hardware

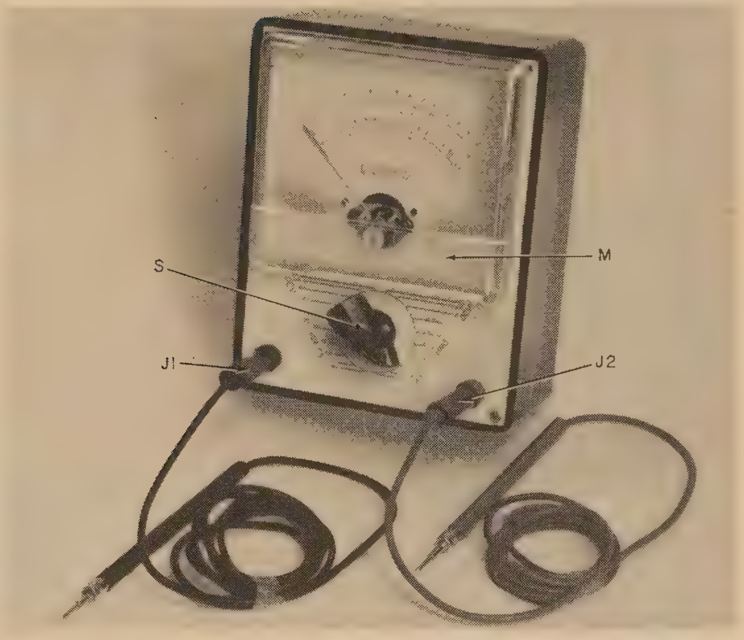
not constant-voltage sources. Their output varies from almost 1.6 (when new) to about 1.3 volts during their useful lifetime. Therefore, a variable resistor is needed to compensate for the variation. In addition, low resistances are measured by passing high current —up to 50 ma on the lowest range— through the unknown resistance. When the battery is new, it doesn't matter. However, as it ages its internal resistance increases and the output voltage drops on the ranges using more current, making it necessary to adjust the zero control constantly when changing ranges.

Mercury batteries are far superior for this purpose as their 1.34 volts per cell remains constant during their useful lifetime. Therefore, the main reason for having an ohms-adjust control does not apply when mercury cells are used as a power source. The 50-ma drain for the low ohms range of most meters is pretty heavy for mercury batteries, but, by using a backup circuit for the two lowest ranges, current is limited to 500 μa. The backup circuit passes full-scale current through the meter and shunts the meter with the unknown resistance. So, when no resistance is connected to the test leads, the meter indicates full scale (infinite resistance). The reading drops as the resistance shunted across the meter is decreased. When the external resistance is equal to the meter's internal resistance, the pointer will be at exactly half scale—in this instrument, 1,300 ohms.

To read lower resistance values than would be possible with this value of half-scale indication, the meter is shunted on the low-resistance range to 500 μa, making 130 ohms the half-scale value for this range. The lowest resistance that can be read on this range is 1 ohm. For reading very low resistance values, I recommend a separate instrument such as the one described in the August, 1953, issue of Radio-Electronics. This reads as low as .01 ohm with a maximum current of 50 ma. It also measures direct current from 50 ma to 10 amps. As I brought out in this earlier article, 50-μa movements are fine for measuring voltage and high values of resistance but aren't suited for low resistance and current. That is why I have only three current ranges and use the saved switch positions for voltage and resistance.

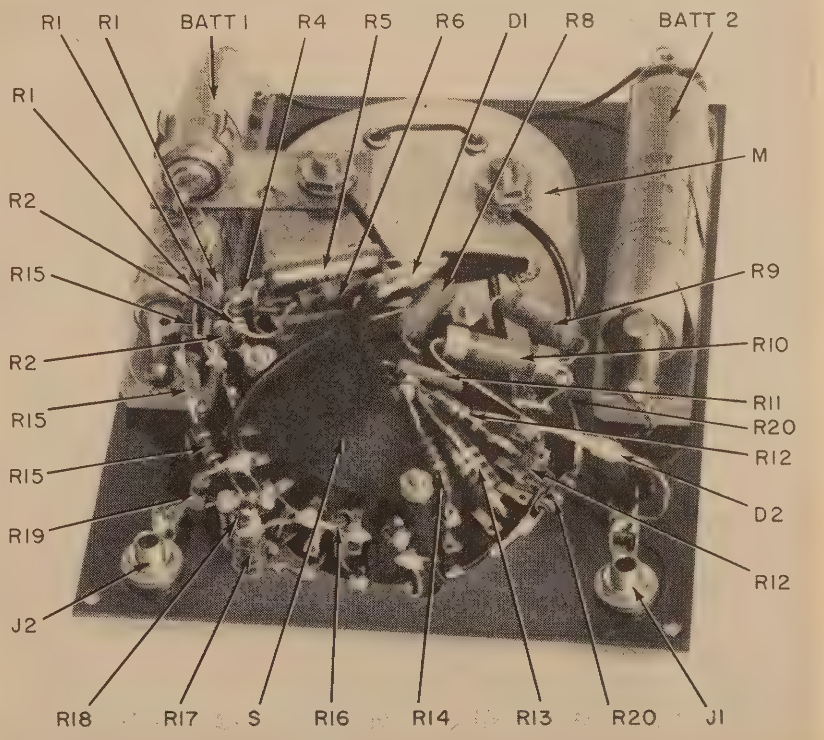
Building the vom

The first step in constructing the instrument is to mount the parts on the panel. This panel is in two layers. One is the bakelite panel that comes with the case, and the other is a plexiglas sheet of the same size. The range dial is sandwiched between these and is a photographic reduction. It isn't difficult to draw one of the proper size. If you can engrave bakelite, you will not need the plexiglas or the paper drawing. I mounted the two large mercury batteries by taping them to strips of plexiglas and fastening the strips with meter



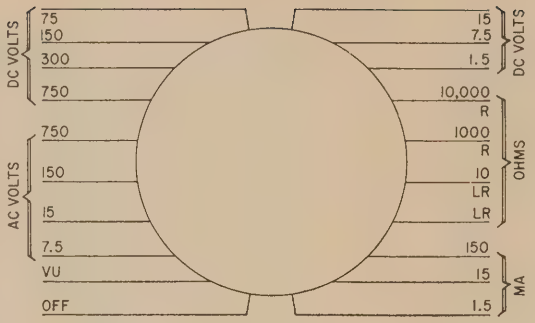
(Above) Neat-looking instrument covers ac and dc volts, ohms, dc ma and db.

(Below) A three-gang switch and associated wiring fills the meter's bakelite case. Each component of resistors built up from several units is marked with the resistor number.

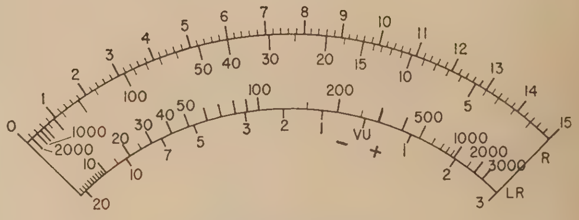


Tests conducted by a member of the staff of RADIO-ELECTRONICS showed that the author's unit is an excellent multimeter. Accuracy, checked against an EICO vtvm at assorted ac and dc voltages, was within 2%. On low resistance ranges the meter did not go to exactly full scale, but when checked by measuring various 1% precision resistors accuracy is within 2%. The meter scales as shown are hard to read. They can be made clearer by adding calibrations for the 7.5-, 75-, and 750-volt ranges.

BENCH TESTED



Range scale shown actual size.



Meter face shown actual size.

E	7.5	15	150	750
DB	+16	+22	+42	+54

mounting bolts. I used brass pillars with a crosswise hole that was tapped for 6-32 bolts instead of nuts. These contact the ends of the batteries and form convenient terminal posts.

One cell is removed from each battery, cutting them down to a total of ten cells. Remove this cell from the positive end of each battery and you will have a tab on the center electrode you can solder to. One of these cells is used for the three low ranges and the other becomes a spare. As shown in the photo, the single cell is mounted in a fuse clip that has been soldered to a piece of brass.

Next, mount the range switch and its knob and the banana jacks. To have as much room for these as possible, mount the meter as high on the panel as you can. The meter scale can be cemented in place either before or after you mount the meter on the panel. It is wise to make a new aluminum backing for the scale as the original is punched for slide-in scales. Before pasting in the scale, remove the 700-ohm resistor in series with the meter coil. Evidently it brings the meter resistance up to an even 2,000 ohms, but the backup circuit works best with low resistances, so the scale has been calibrated for a 1,300-ohm movement and is accurate for only this value. If you are using another make meter and it has a lower resistance, you could add some series resistance to bring it up to 1,300 ohms. Be sure to get one with a lance or knife-edge pointer. The arc is 90°.

Wiring details

All other components can now be soldered in place. Note that except for the deposited-carbon resistors all are of nonstandard values. You will have to borrow a good ohmmeter or resistance bridge and select them from a stock of common carbon resistors. The wire-wound resistors are made up from No. 30 copper wire wound on forms made of high-value radial-lead carbon resistors.

Starting with the ohms section, install R19, the 500-μa shunt. You may find a nominal 150-ohm carbon resistor that is just right or you can use some series or parallel arrangement to get the exact value.

The multipliers for the dc ranges (R3 to R9) are mostly deposited carbon. R3 is an odd value to compensate for the meter resistance. Only two of the ac multipliers (R10 and R11) are standard values. Two factors to consider for ac are rectifier efficiency and linearity. Install R10 and R11 and set the range switch to 150 volts ac. Connect a 10,000-ohm variable resistor as a temporary R20 and set it to minimum. Touch the test leads to the ac line and adjust the pot until the meter gives the same reading as your standard voltmeter. Then replace the variable control with a fixed resistor of the same value. It should be approximately 1,050 ohms. If you have a really accurate ac voltmeter, you could improve accuracy on the 15, 7.5 and VU range by adjusting R12, R13, R14 until the readings agree with your standard. But if you have done a good job on the ohms section and have measured these resistors accurately, you should be within the usual 5% accuracy for ac meters.

Design factors

You will notice that I do not use a separate meter scale for ac. This is a big advantage, but it requires paying attention to rectifier linearity. The extra diode that shorts the meter and rectifier during the undesired half-cycle helps improve linearity as no current leaks through during this period. However, when dealing with currents of 5 μa or less, diodes increase in forward resistance and decrease in back resistance, therefore losing their efficiency. Even silicon diodes that may have a back resistance of 10,000,000 ohms for larger currents act this way. Their back resistance may drop to 20,000 ohms near zero current. I found that 1N34's are as good as any for this purpose.

If we try to make the ac ranges as sensitive as possible, we run into linearity problems. The 5-μa point below which the rectifiers act more like resistors than rectifiers represents a considerable part of the arc. But if we decrease the sensitivity by shunting the meter, this effect becomes less important. I found that 4,000 ohms per volt is the greatest sensitivity that will give reasonable linearity. True, 2,000 ohms per volt would be better, but it would load some circuits excessively.

The VU range is not shunted as linearity isn't as important and I wanted to approximate the standard VU meters. There are quite a few problems when one tries to have a VU range on a multimeter. This is mainly because of meter movements' characteristics. VU types are more lively due to less damping and possibly more torque. For audio work, 0 db is 1 mw in a 600-ohm line or 0.775 volt. Standard VU meters do not indicate zero at this level but at 6 db down from 10-mw. However, I had to use 0.775 volt as zero to use the higher ranges for decibels, so this meter will indicate zero VU when the level is 1 milliwatt. This applies only for steady tones; for male speech the readings will be very close to a standard VU meter because of the more sluggish movement. For steady tones you can match a standard VU meter by adding 7,500 ohms in series with the test leads. For the higher ranges, add the appropriate number of decibels shown in the box on the meter scale.

The shunt resistors for dc are difficult to measure accurately, especially R17 and R18. For best results check them against a good standard by passing current through both meters in series.

I would like to give my reasons for selecting the voltage ranges by indicating the uses for each:

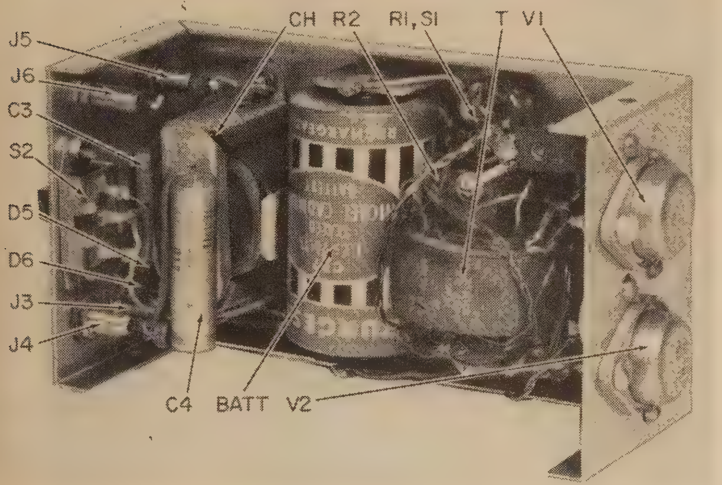
Dc ranges
1.5—dry cells, mercury cells, filaments of 1.4-volt tubes
7.5—6-volt storage batteries
15—12-volt storage batteries, 9-volt transistor supplies
75—multiple of 15, bias of output tubes
150—transformerless plate voltages
300—transformer type plate voltages
750—multiple of 150
Ac ranges
VU—telephone and low-level audio
7.5—6.3-volt heaters
15—12.6-volt heaters
150—ac line, heaters of higher-voltage tubes
750—multiple of 150, input to rectifiers

END

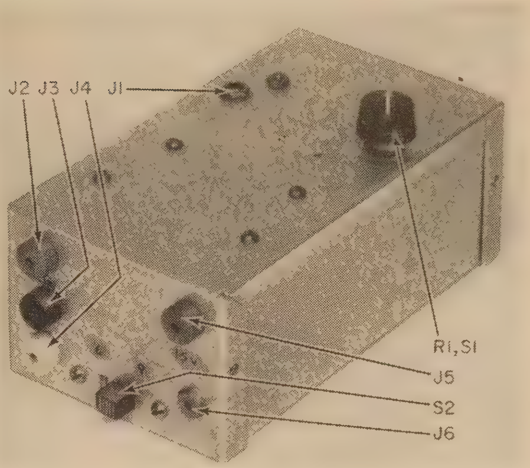
PORTABLE POWER SUPPLY

1.5, 6.2 and 9.1 volts regulated and about 20 volts semiregulated dc are the outputs of this 5 x 3 x 2-inch device

By I. QUEEN
EDITORIAL ASSOCIATE



The case looks crowded, but there is plenty of room for all the parts. Note the power transistors mounted on the rear of the case.



The finished unit is small enough to fit in the palm of your hand.

THIS supply is suitable for transistor circuits. It provides 1.5, 6.2 and 9.1 volts with excellent regulation. There is also a semiregulated output of about 20 volts. The power source is a size-D flashlight cell which energizes a transistor oscillator. The voltage is stepped up, rectified and then regulated by a Zener diode.

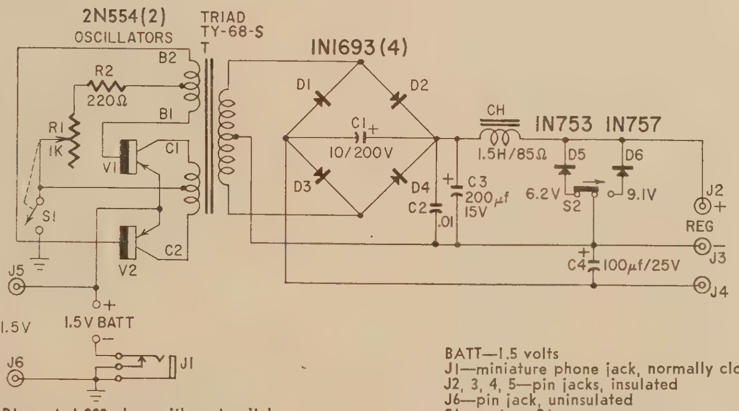
Potentiometer R1 controls the input to the oscillator. Its resistance is set as high as possible for the amount of power needed, to save battery power. You can measure the drain by plugging a meter into jack J1.

Four inexpensive diodes make up the bridge rectifier. Each one can handle up to 200 volts peak at high temperature. The choke's resistance must be low. Since ripple frequency is quite high, even a low inductance filters effectively.

There is no direct connection between the 1.5 volts from the D-cell and any of the stepped-up voltages. Thus the 1.5 volts may be combined with any of the others. For example, 6.2 volts minus 1.5 gives 4.7 volts.

The power box measures 5 x 3 x 2 inches. Transistors are mounted at one end, using a Motorola mounting kit available for this purpose. Correct polarity of the transformer is important. Base and collector windings are labeled B1, B2, C1, C2. *B1 and C1 must connect to the same transistor.*

Here are some of the advantages of this power source. It replaces expensive batteries and needs only a common flashlight cell. A maximum of about 20 ma is available from the regulated voltages. An aging D-cell lowers this maximum, but cannot affect the *voltage* set by a Zener diode. Contrast this with direct battery operation where the battery *voltage* begins to drop as soon as it is put to use. Like a TV flyback circuit, this one puts out a limited amount of power, so it has built-in safety. If more than 20 ma is taken from one of the regulated voltage taps, the output drops sharply. The short-circuit current is only about 1 ma. This means greater safety for the power supply itself and for the transistors you energize.



R1—pot, 1,000 ohms with spst switch
R2—220 ohms, ½ watt
C1—10 μf, 200 volts, electrolytic, miniature
C2—.01 μf, 500 volts, disc ceramic
C3—200 μf, 15 volts, electrolytic, miniature
C4—100 μf, 25 volts, electrolytic, miniature
CH—1.5 henries, 85 ohms
D1, 2, 3, 4—1N1693
D5—1N753
D6—1N757
BATT—1.5 volts
J1—miniature phone jack, normally closed
J2, 3, 4, 5—pin jacks, insulated
J6—pin jack, uninsulated
S1—spst on R1
S2—spdt slide
T—transistor power supply transformer, 12 volt dc input, 250 volts, 65 ma from rectifier (Triad TY-68S or equivalent)
V1, 2—2N554
Mounting kit for transistor
Holder for battery
Case, 5 x 3 x 2 inches
Miscellaneous hardware

Circuit of the simple portable power supply.

At full drain, the D-cell will deliver nearly 250 ma. At light loads, the drain will be about 60 to 100 ma, which extends cell life to 30 hours or more.

If this power supply will be used often and at moderate drains, your best bet is to use one of the new rechargeable nickel–cadmium cells. I find a Burgess CD-7 very satisfactory for this application. At 250-ma drain it lasts 10 hours before recharging is needed. END

10 transistors at your fingertips. Just flip a switch to select the one you want

TRANSISTOR SUBSTITUTION BOX

By LEONARD J. D'AIRO*

THIS transistor substitution box has proved to be a pretty valuable piece of equipment on a number of occasions when transistor circuits were being checked out. It has taken a rightful place in my workshop, alongside the resistance, capacitance and inductance substitution boxes.

In this unit, there are substitutes for 10 transistors. Included are general-purpose, small-signal audio, large-signal audio, power and rf types. Selection is for useful characteristics and any combination may be used.

The combination shown in the schematic covers most practical applications. These transistors are:

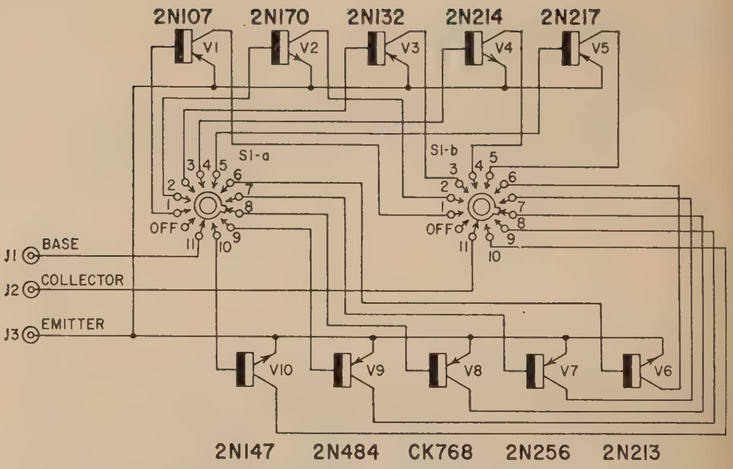
General purpose 2N107, 2N170
Small-signal audio 2N132, 2N214
Large-signal audio 2N217, 2N213
Power 2N256
Rf CK768, 2N484, 2N147

Note that in the first three groups, one transistor is a p-n-p and the other is an n-p-n, while the power transistor is a p-n-p (since most applications use a p-n-p unit). In the rf group, two transistors are p-n-p's and one is an n-p-n.

A transistor substitution box is, of course, much more expensive than the more usual capacitor or resistor substitute array, at first sight so much so as to appear impractical. But until we get a great deal more familiar with transistor receivers and can spot a bad transistor more easily, the positive answers it gives save enough servicing time to pay for it very quickly.

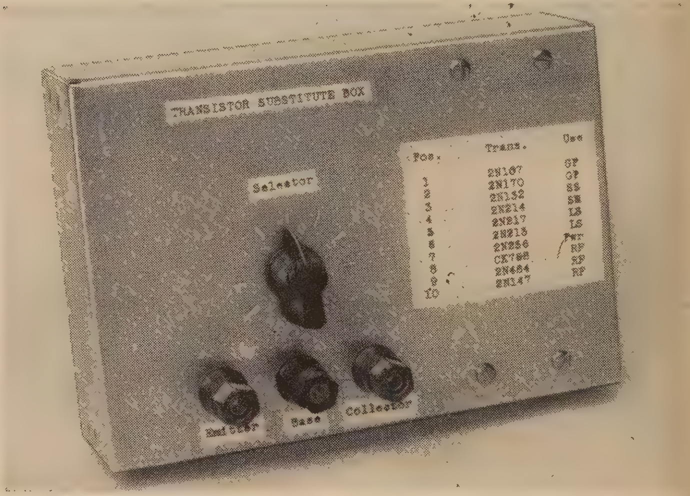
The transistors suggested in the parts list represent the average units used in transistor radios, amplifiers and related equipment. The types that are finally chosen and used should match the particular requirements of the user.

A cigar box or aluminum chassis box can be used to mount the selector switch and transistors. All wiring must be quite rigid and as short as possible. The power transistor must be mounted on a heat sink and kept as far as possible from other transistors. END



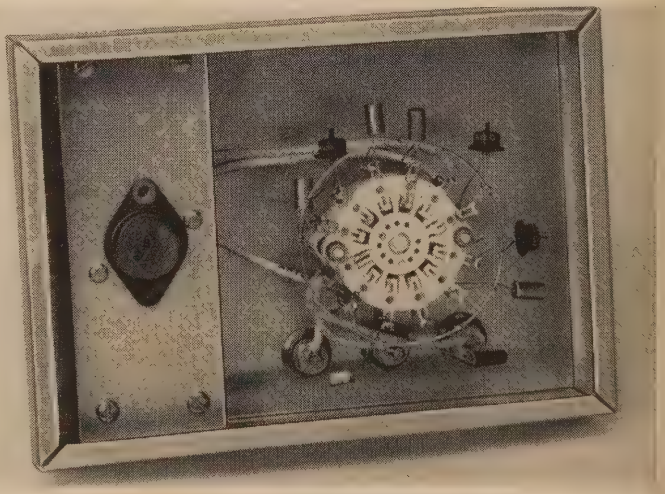
J1, 2, 3—3-way binding posts or tip jacks
S1—2-pole 12-position rotary, nonshorting
V1—2N107
V2—2N170
V3—2N132
V4—2N214
V5—2N217
V6—2N213
V7—2N256
V8—CK768
V9—2N484
V10—2N147
Chassis box to suit
Miscellaneous hardware

Circuit of the substituter.



Pos.	Trans.	Use
1	2N107	GP
2	2N170	GP
3	2N132	SS
4	2N214	SS
5	2N217	LS
6	2N213	LS
7	2N256	Pwr
8	CK768	RF
9	2N484	RF
10	2N147	RF

Front panel of the transistor substitution box. Chart at right shows which transistor is in use.



Inside the substitution box. Author used transistors other than those in the schematic and listed on the box's front panel to match his own special requirements.

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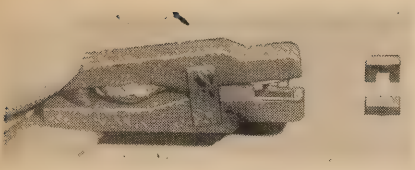
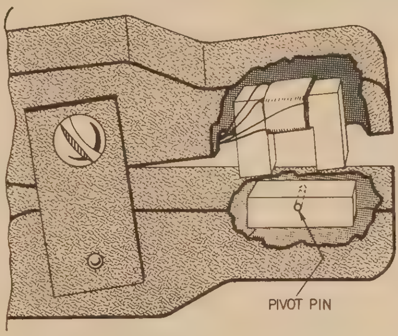
*Author *Servicing Transistor Radios*, Gernsback Library.

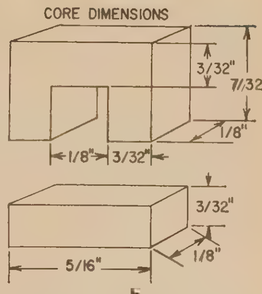


CLAMP TYPE AC MICROAMMETER

THE circuit shows a portable battery-powered ac microammeter developed by the National Bureau of Standards. It will measure currents between 200 μa and 200 ma over a frequency range of 50 to 100,000 cycles.



a


CORE DIMENSIONS
3/32"
7/32"
1/8"
1/8"
3/32"
3/32"
1/8"
5/16"

b

Fig. 1—Construction and mounting details of the pickup transformer.

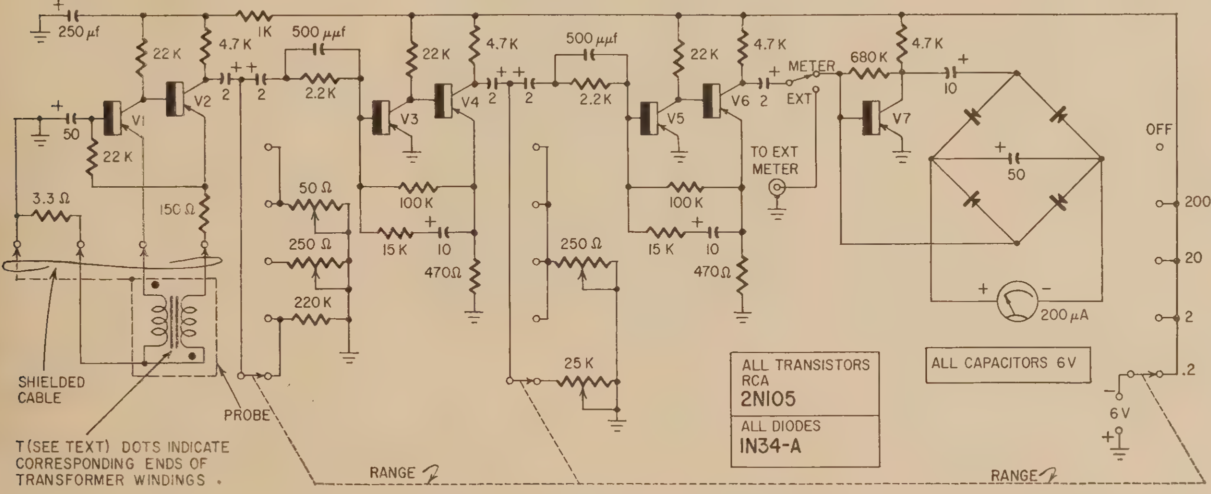
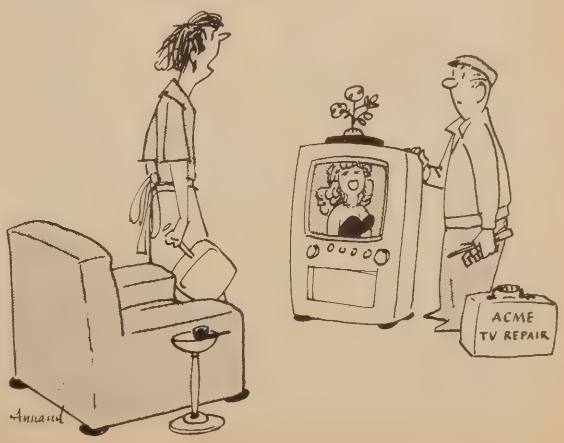

250 μf
22 K
4.7 K
1K
500 μμf
2
2
2.2 K
22 K
4.7 K
500 μμf
2
2
2.2 K
22 K
4.7 K
2
METER
EXT
680 K
4.7 K
10
V1
V2
V3
V4
V5
V6
V7
50
22 K
3.3 Ω
150 Ω
50 Ω
250 Ω
220 K
100 K
15 K
10
470Ω
250 Ω
25 K
100 K
15 K
10
470Ω
TO EXT METER
50
OFF
200 MA
20
2
.2
200 μA
6V
SHIELDED CABLE
PROBE
T (SEE TEXT) DOTS INDICATE CORRESPONDING ENDS OF TRANSFORMER WINDINGS .
RANGE
RANGE
ALL TRANSISTORS RCA 2N105
ALL DIODES 1N34-A
ALL CAPACITORS 6V

Fig. 2—Circuits of the all transistor meter.

The jaws of the probe contain the most difficult part of the unit—a pickup transformer. It is built as shown in Fig. 1. The core consists of C and I sections of 0.014-inch silicon-steel laminations with dimensions as in Fig. 1-b. Each winding consists of 250 turns of No. 44 enameled wire. Both are wound on the C-shaped section of the core. One winding of transformer T is the secondary and picks up the actual current. The transformer's primary is, of course, the conductor carrying the current to be measured. The other winding, the tertiary, forms part of a feedback circuit which provides frequency equalization. This winding makes the transformer's output between 100 and 100,000 cycles linear for a particular primary current.

The transformer's output is fed to the first part of the meter's circuitry (see Fig. 2), a two-transistor preamp. Gain in this stage is cut down by feedback which provides frequency stabilization and reduces phase shift at the higher frequencies. Two intermediate stages, each using two direct-coupled transistor amplifiers deliver the needed gain—about 20 db per stage. A 200 μa dc meter is the indicator and is driven through a full-wave bridge.

The transformer core is mounted in a spring-loaded bakelite clamp, about the size and shape of an ordinary clothespin (Fig. 1-a and head photo). The legs of the C project downward from the upper jaw of the clamp, while the I is contained in the lower jaw. A pin passes through the center of the I, providing rotary movement in the plane of the jaws, so that the I will seat itself properly on the projecting legs of the C and close the gap as the clamp closes. The matching faces of these parts are ground. Shielding with Mumetal minimizes sensitivity to external magnetic fields. END


ACME TV REPAIR
Annand

"Is there any way you can adjust it so the girls look tall and skinny and flat-chested?"

COVER FEATURE

STOP FEEDBACK in PUBLIC ADDRESS SYSTEMS

The inventor of a completely new system of acoustic feedback elimination tells how it works in a story prepared especially for this magazine

By M. R. SCHROEDER *

FEEDBACK is one of the fundamental facts of life. Without it we couldn't live and our machines wouldn't run. Basically, feedback means that the output of a something acts on itself, thus forming a feedback loop. The something can be a machine, a human being, a group of people, a plant—almost anything one might imagine. The action can be either inhibiting (negative feedback) or stimulating (positive feedback). A guest at a cocktail party who feels the effect of a drink and decides to reduce his further intake is an example of negative feedback. Negative feedback generally leads to a stable situation.

Not so, usually, positive feedback. Imagine another guest at the same party who feels stimulated in proportion to his previous consumption. This is a clear example of positive feedback leading to complete instability in the original mechanical sense of the word. Another example of positive feedback leading to instability is a burning house. Once the fire has started, the hotter it gets, the faster the rest of the house will burn down—unless the firefighters arrive in time. And that's what this story is concerned with: firefighting the instability resulting from positive feedback in a public-address system.

Feedback in PA systems

While feedback is desirable and even essential in many instances, in public-address (PA) systems it certainly is not. It leads to the well-known "singing" and often outright "howling," rendering the system not only useless as far as amplifying the speaker's voice is concerned but actually annoying from the listener's standpoint.

Why does it happen? The answer to this question is simple: the sound from the loudspeaker(s) gets back into the microphone—either directly or after bouncing off the walls of the room and other obstacles. If the total sound amplitude reaching the microphone from the speaker exceeds what went into the microphone in the first place and if this feedback sound is in phase with (reinforcing) the original input, we have positive feedback leading to instability which shows up as audible howling.

The next question is: what can one do about it? Again, the answer seems to be simple: turn the amplifier gain down! Here, however, we are running counter to the very purpose of PA systems—to amplify sound, not to attenuate it. In other words, there is competition between two basic requirements of a PA system: sufficient amplification on one side and stability on the other side.

Of course, one could sidestep the whole feedback problem by putting the orator in a glass-walled isolation booth. However, apart from the considerable cost involved, this does not look like a very popular proposal. (Also, the speaker might fear that the credibility of what he has to say is impaired by speaking from an isolation booth!)

Thus, the basic task of somehow reconciling sufficient amplification with stability when loudspeakers and microphones operate in the same sound field is still to be solved. Several proposals to improve this situation have been made in the past and are successfully used in existing PA systems. We shall discuss these first.

Imagine a PA system plagued with predominantly direct sound feedback. This happens when loudspeaker and microphone are fairly close to each other. Suppose further that the speaker has a strong response peak (a resonance) at some frequency. Then the maximum permissible gain for stable operation is given by the height of that response peak. If it sticks out 10 db above the otherwise flat response of the loop path of microphone–amplifier–loudspeaker–air–microphone, maximum permissible amplifier gain is 10 db less than what it would be without that resonance peak. The loudness, on the other hand, is not increased by the narrow response peak, except at frequencies close to the resonance. So this time the loudness–stability compromise can be improved by equalizing the response peak of the speaker. It can be done by incorporating an adjustable anti-resonance in the system's preamplifier or power amplifier. Commercial amplifiers that use this principle have been on the market for some time and we need not concern ourselves with this case any more except to remember two things:

- Peaked responses are poison for PA systems.
- Equalizing such response peaks allows greater stable sound amplification.

Another powerful antidote for acoustic feedback is the use of directional microphones and speakers. This method is used extensively, and almost instinctively, in the field. Usually, loudspeakers and microphones have some degree of directionality and people place them so that as little sound as possible radiates directly from the speaker into the microphone. Nobody who has any feeling for the principles involved would place the microphone right in front of the loudspeaker.

Unfortunately, eliminating the *direct* sound feedback does not get rid of *all* feedback. There is still the indirect sound, reflected from the walls, ceiling, floor, audience, etc.—what room acoustians call the reverberant sound. To understand its effect and to minimize it, we must learn a little about room acoustics.

Luckily, all we need to know about room acoustics are some of the characteristics of steady-state frequency responses of rooms. One obtains the steady-state frequency response between two points in a room by putting a loudspeaker at one point, a microphone at the other, supplying the speaker with a tone of slowly varying

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* Bell Telephone Laboratories, Inc., Murray Hill, N. J.

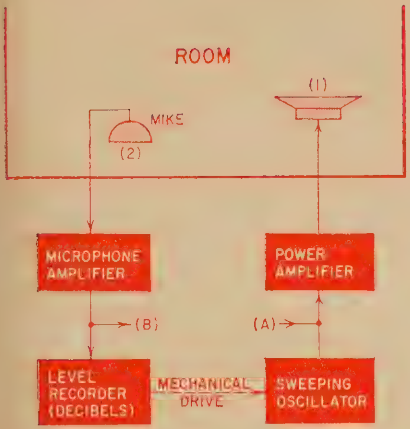

Fig. 1—How to get the steady-state frequency response between two points in a room.

frequency and recording the output of the microphone with a level (decibel) recorder. This is shown in Fig. 1. Such an experiment was performed by E. C. Wente[1] at Bell Telephone Laboratories in 1935. Dr. Wente was very much surprised at what he saw when he looked at the response records. A small section of such a frequency is reproduced in Fig. 2. In Dr. Wente's own words: "Within this small range of frequency, there are a large number of peaks and valleys and the variations in level are as much as 40 db. Any communications engineer looking at this transmission curve would classify the corresponding transmission system as a very poor one, perhaps incapable of transmitting intelligible speech."

Nevertheless, this is the kind of response a PA system operating in a room has to cope with and, as we pointed out above, it is just poison. The amplification or loudness of the PA system plus the room is given by the average level, $g_{average}$, indicated by a dashed line in Fig. 2. The maximum permissible stable gain is limited by the highest response peak, indicated by g_{max}. If rooms had flat responses (the dashed line in Fig. 2) or if they could be flattened by some trick, the gain could be raised by an amount equal to the difference between g_{max} and $g_{average}$, 12.5 db in the example of Fig. 2.

However, while it is not too difficult to equalize a single peak, a loudspeaker's resonance for instance, it becomes completely impossible in the case of the myriad peaks of a room. Typically, a room has several thousand such peaks in the audio range.[2] To make things worse, these peaks are not fixed. They move about as the location of the person speaking, the microphone, the loudspeaker or the audience is varied. In other words, the response of a room cannot be equalized. We just have to live with it.

The frequency-shifting idea

If we cannot do anything about the room, perhaps we can do something about the signal radiated by the loudspeaker. More specifically, we may ask whether we can modify the signal so it no longer cares how jagged the room response is or, to put it differently, so its feedback stability is determined not by the peaks of the response but by the average level. Furthermore, is there such a modification that is at the same time imperceptible to the audience? This sounds like asking too much. But, fortunately, the answer to both these questions is yes.

The trick is to shift all frequency components of the signal by a small but constant amount. The frequency-shift apparatus may be inserted between the microphone amplifier and the power amplifier, as shown in Fig. 3, or incorporated in either one.

Telephone engineers have found that small frequency shifts of speech signals, a few cycles per second, are nearly imperceptible and that frequency shifts as large as 20 cycles are still tolerable.[3] In fact, involuntary frequency shifts occur all the time in single-sideband telephony. Every time we make a long-distance call, our voice arrives at its destination shifted by a few cycles in frequency.

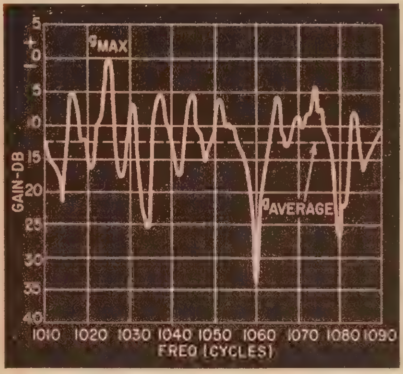

Fig. 2—Over an 80-cycle spread, amplifier gain may show a variation of more than 30 db.

Now that we know that frequency shifting does not hurt us, the next question is, "Does it help?" To answer it, we refer again to Fig. 2. As the signal we assume a simple 1,025-cycle sine wave. The gain for this frequency is g_{max}. If in Fig. 1 the input of the power amplifier (A) is connected to the output of the microphone amplifier (B) to form a PA system and if the gain is raised by a slight amount, our sine wave will continuously grow in amplitude for every trip around the feedback loop.†

With frequency shifting (see Fig. 3), the picture is completely changed because, for every trip around the feedback loop, the frequency of our signal is shifted by, say, +5 cycles. Thus, on the second trip around, the signal frequency is 1,030 cycles for which the loop gain, according to Fig. 2, is about −10 db. On the third trip around the feedback loop, the signal frequency is again shifted by +5 cycles and is now 1,035 cycles. The gain for 1,035 cycles is again about −10 db. And so forth. In short, the cumulative amplification of a signal as it goes round and round the feedback loop is no longer determined by the possibly very high gain at its original frequency but by the average gain of the room response. Thus, while the room response is actually unchanged, from the feedback point of view it is as if the peaks of the response had disappeared and been used to fill up the valleys of the response curve. Frequency shifting does the seemingly impossible. No matter how jagged the response is, it completely flattens it, at least as far as feedback stability is concerned. And that is what we are interested in.

An approximate theoretical formula[5] has been derived for the difference between the maximum and the average gain—the extra stable gain to be expected from frequency shifting:

$$g_{max} - g_{average} = 10 \log_{10} [\log_e TW] + 2.5 \text{ db}$$

Here T is the average reverberation time of the room and W is the bandwidth of the PA system. And e = 2.718 –the base of the natural logarithms. Because of the double logarithm, the result depends little on T and W. For example, if W = 5,000 cycles and T = 1 sec, $g_{max} - g_{average} = 11.8$ db. For T = 2 sec, $g_{max} - g_{average} = 12.1$ db.

Thus, one may say that from a stability point of view, the permissible increase in gain when using frequency shifting is about 12 db. This theoretical prediction is borne out by the measurements (Fig. 4).

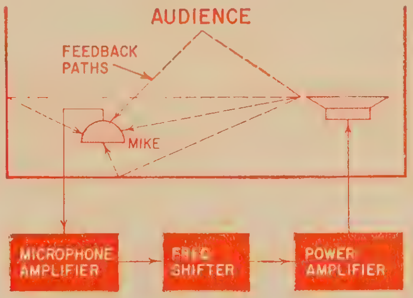

Fig. 3—The frequency shifter is inserted between the microphone amplifier and the power amplifier.

From a subjective point of view, the performance has to be evaluated differently. Without frequency shifting, the loop gain must remain below approximately −3 db for the "singing" to be tolerable. *With* frequency shifting, the gain can be raised to +3 db, for similar subjective acceptability. For gains in excess of +3 db, the performance of the PA system, while still stable, becomes less and less pleasing. Thus, from a subjective point of view, frequency shifting is worth about 6 db of in-

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† In addition to the loop gain exceeding zero db, a certain phase condition[4] has to be fulfilled. However, among the thousands of peaks of a room, one can always find several for which this condition is fulfilled if the maximum loop gain exceeds zero db by a small amount.

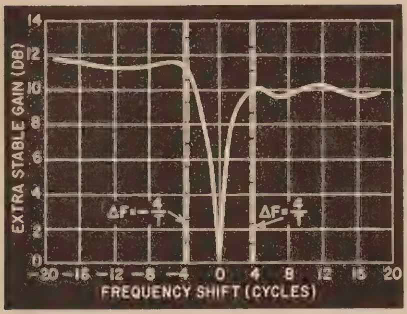

Fig. 4—From the viewpoint of stability, phase shift permits about a 12-db increase in gain.

creased gain plus several decibels of additional margin against howling.

Optimum frequency shift

Now that we know that frequency shifting is so helpful, the question naturally arises as to whether there is an optimum value for the amount of shift. Here again a look at Fig. 2 provides the answer. Obviously, if we are shifting only a minute amount, say 1 cycle, it will take the signal many trips around the feedback loop (Fig. 3) before it is shifted enough in frequency to reach the next valley—a point of low amplification. In the meantime, the signal may have built up to a very large amplitude. An optimum or, in any case, a good value for the frequency shift is the average distance between the peaks and valleys. In this manner, a frequency component that starts out at a point of high gain reaches a point of low gain as quickly as possible, namely after one trip around the feedback loop.

The distance between the response peaks and adjacent valleys of a room is roughly 4 divided by the reverberation time.[6] Since most rooms have reverberation times of about 1 second, a good value for the frequency shift is 4 or 5 cycles. This prediction is confirmed by our measurements in various auditoriums and rooms. Fig. 4 shows the extra stable gain that can be realized by frequency shifting as a function of the amount of the shift. These measurements were made in the Bell Telephone Laboratories Auditorium at Murray Hill, N. J. The average reverberation time, T, in this auditorium is very close to 1 second. Thus, the theoretically required shift is 4 cycles. Fig. 4 shows that a shift of this magnitude is indeed sufficient. For larger shifts, the extra stable gain remains between 9.5 and 12 db. This means that the actual shift is not very critical as long as it is more than 4/T cycles. The fact that negative shifts give somewhat better results than positive shifts has no general significance. It is advisable to use frequency shifters which can shift both upward and downward and to decide in each case which direction of the shift is preferable.

Single-sideband frequency shifting

A convenient method of effecting a constant-frequency shift is single-sideband modulation as shown in Fig. 5. The signal is first amplitude-modulated upon a carrier frequency of, say, 20 kc. A bandpass filter with a sharp lower cutoff (SSB FILTER 20KC–30KC) removes the lower sideband. The upper sideband is then demodulated by a carrier of, say, 19.995 kc. The resulting signal has all its frequency components shifted by +5 cycles. The only technical problem is to keep the difference frequency between the two carriers close to the desired amount—5 cycles in our example. This can be done with crystal-controlled oscillators, negative feedback control, or by deriving the second carrier frequency from the first one and a 5-cycle sine wave by "quadrature modulation" as illustrated in Fig. 5. Note that the 20-kc oscillators are made up from a 40-kc oscillator and frequency-dividing flip-flops. A circuit of this kind, using 29 transistors, was used in our experiments and demonstrations. We are now building a frequency shifter with crystal controlled oscillators. This promises much simpler, more reliable and less critical equipment. The improved frequency shifter will be described in detail in a forthcoming publication.

A word of caution

Frequency shifting offers a powerful protection against howling caused by acoustic feedback. Because of the extremely widespread use of public-address systems, the method described here could be of benefit to many people—audiences and speakers alike. However, like any invention, it should be used intelligently. In particular, one should not exploit the additional stable gain exclusively for greater amplification (loudness). Rather, one should reserve a certain portion of the extra stable gain as an additional insurance against accidental increases in feedback that may be caused by heating up of amplifiers, changes in the audience or of the speaker's location. Such intelligent use could be enforced by providing access to the volume control only when the frequency shifter is inoperative. In this manner the gain would never be adjusted to a value above the singing point (except by deaf people). After setting the gain potentiometer and switching in the frequency shifting, the system would have a safety margin of about 10 db against instability and a 3–6-db margin against undesirable subjective effects. In addition, there is a considerable increase in loudness because a PA system without frequency shifting has to be operated several decibels below the singing point.

Acknowledgements

I am grateful to Dr. Erwin Meyer, my professor at Goettingen University, for bringing me into contact with the interesting problems of steady-state sound transmission in rooms, the solution of which formed the basis of the present invention. I am also indebted to Drs. J. R. Pierce and E. E. David, Jr., at Bell Telephone Laboratories, for drawing my attention to the acoustic feedback problem. Mr. H. W. Hines assisted me in the construction of the frequency-shift apparatus, and Mr. J. E. West helped me with the measurements. END

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[1] E. C. Wente, *J. Acoust. Soc. Am.*, Vol. 7 (1935), p. 123.

[2] H. Kuttruff and R. Thiele, *Acustica*, Vol. 4 (1954), p. 614 (Beiheft 2).

[3] H. Fletcher, *Speech and Hearing in Communication*, D. Van Nostrand Co., New York (1953), p. 352.

[4] H. Nyquist, *Bell Syst. Tech. J.*, Vol. 11 (1932), p. 126.

[5] M. R. Schroeder, *Proceedings of Third International Congress on Acoustics*, Elsevier Publishing Co., Amsterdam (1960) (to be published).

[6] M. R. Schroeder, *Acustica*, Vol. 4 (1954), p. 594 (Beiheft 2).

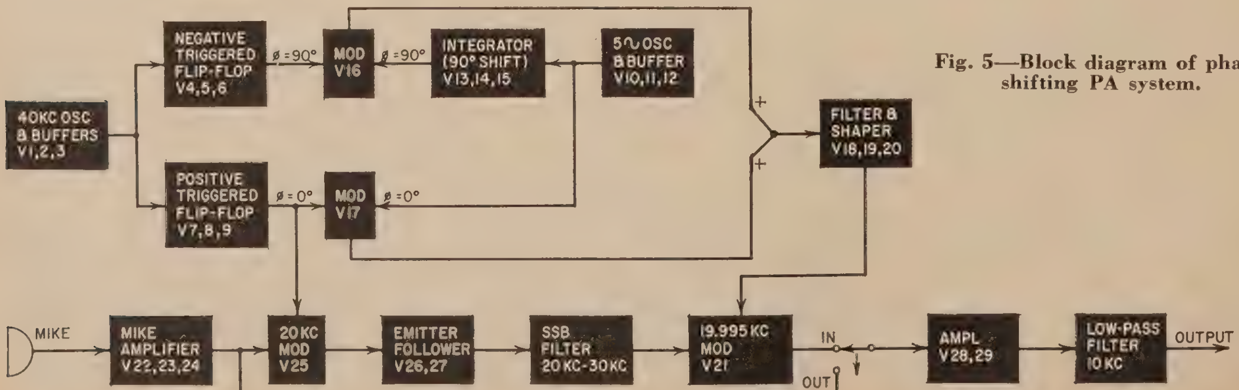
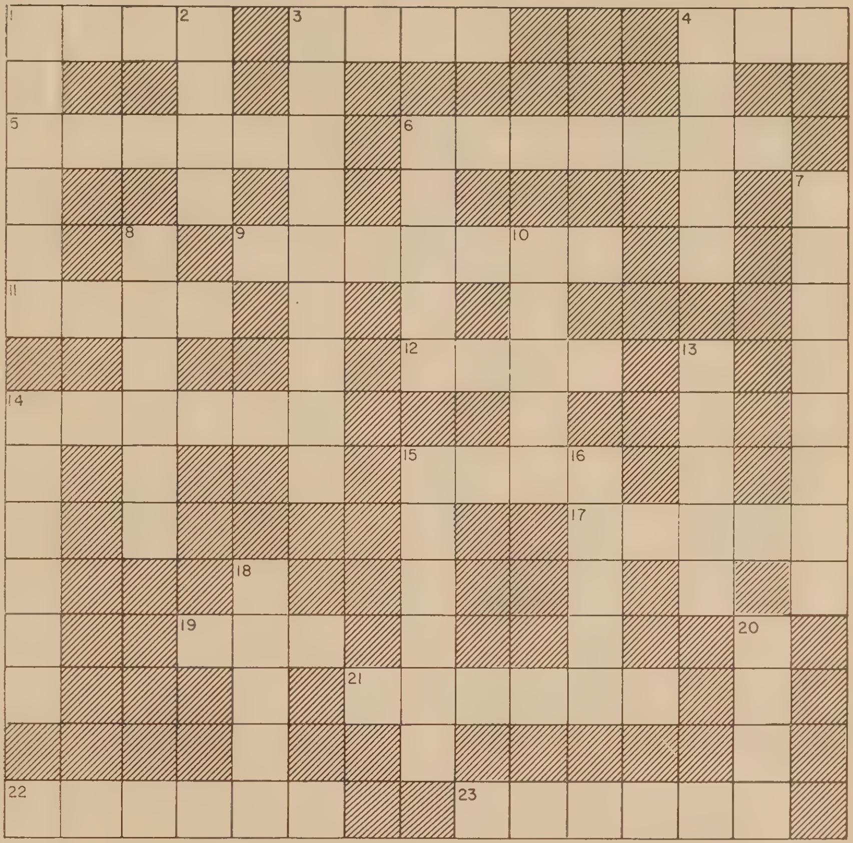


Fig. 5—Block diagram of phase-shifting PA system.

TAPE RECORDER WORD PUZZLE

By JOHN A. COMSTOCK

HERE is a sound-on-tape puzzle for you to work that is made up entirely of tape-recording words and terminology. If tape recording is your hobby or interest, you will find this puzzle fun to do, and a challenge, too!
(Answer on page 132)



ACROSS

1. Iron-oxide-coated plastic or paper ribbon.
3. The metallic oxide on recording tape.
4. A playback head with a narrow --- provides better high-frequency response than a head with a wide one.
5. A tape recorder with fast ------ saves one's patience in waiting to hear the playback.
6. Material which serves as a base for most recording tapes.
9. A type of plastic which serves as a base for some recording tapes.
11. Many recorders have two speeds. They are called ---- speed units.
12. The tape recorder part that places magnetic variations on tape.
14. A recorder which is capable of giving a three-dimensional sound effect.
15. A microphone (slang).
17. The spools on which tape is wound.
19. A slow unsteadiness of sound volume and pitch caused by variations in the tape's speed as it travels by the record or playback head.
21. Type of tape added at the beginning of a reel. Often used for indexing.
22. To put intelligence on tape.
23. When the stop button is depressed, the ------ stop both reels simultaneously.

DOWN

1. In selecting a tape recorder, one should choose a recorder that is easy to ------.
2. To cut out portions of tape and eliminate unwanted material.
3. Some recorders have a VU meter as a record level --------- while others have a tuning eye or neon lamp that serves the same function.
4. Some recorders have a tape ----- or roller around which the tape passes to keep it correctly positioned.
6. Jumper cord used to record from radio, TV or record player.
7. If music is to be recorded, it is advisable to select a faster tape speed to improve frequency --------.
8. The reel on which tape is wound during playback and recording.
10. Most recorders are dual -----.
13. When recording, you must watch the record ----- indicator to prevent distortion due to overmodulation.
14. Join two pieces of recording material.
15. A ------ passed over a tape will remove the recorded intelligence.
16. Tape may be used almost indefinitely because it is possible to ----- the tape and use it over again almost any number of times.
18. The electromechanical device which provides power to turn the reels and move the recording tape.
20. The current which flows through the recording head and sets up a varying magnetic field.

END

High-Fidelity AM Broadcast Station

WLW in Cincinnati has rebuilt its equipment completely for hi-fi sound an an attempt to parallel on AM what some FM broadcasters have been doing. After the reworking job, which cost $300,000, the 50-kw station claimed it is "the highest-fidelity station in the world." The statement also carried these details: "within ±1 db from 17 to 21,500 cycles, with distortion less than 0.3%."

Frank McIntosh, head of McIntosh Laboratories, prominent high-fidelity equipment maker, and inventor of the McIntosh "unity-coupled" audio output circuit, made measurements and tests on the rebuilt equipment and the broadcast signal. He said that the station is providing as high-quality transmission to its listeners as any station on the air.

WLW has changed its programming from the top 40 tunes and rock'n'roll to one of standard tunes, show music and classical selections. The business manager says they've increased the number of regular listeners appreciably, and are selling more commercial time than before the changeover. Apparently high fidelity *can* be profitable.

RCA's 2-WAY STEREO AMPLIFIER

Unique circuit lets the customer add a speaker and flip a switch to change his single-channel push-pull amplifier into a dual single-ended job for stereo reproduction

By ROBERT F. SCOTT
TECHNICAL EDITOR

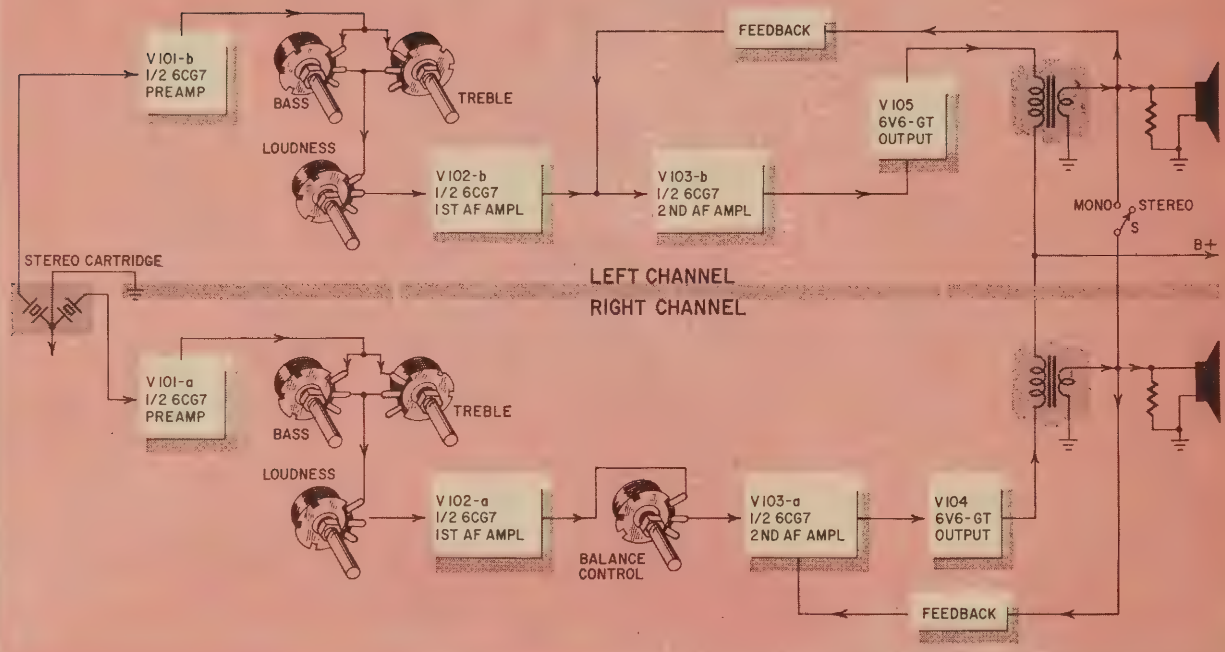

V101-b
1/2 6CG7
PREAMP
BASS
TREBLE
LOUDNESS
FEEDBACK
V102-b
1/2 6CG7
1ST AF AMPL
V103-b
1/2 6CG7
2ND AF AMPL
V105
6V6-GT
OUTPUT
MONO
STEREO
S
B+
STEREO CARTRIDGE
LEFT CHANNEL
RIGHT CHANNEL
V101-a
1/2 6CG7
PREAMP
BASS
TREBLE
LOUDNESS
V102-a
1/2 6CG7
1ST AF AMPL
BALANCE
CONTROL
V103-a
1/2 6CG7
2ND AF AMPL
V104
6V6-GT
OUTPUT
FEEDBACK

Fig. 1—Basic diagram of the RCA circuit.

DURING a year that stereophonic records and tapes have been widely available at reasonable prices, reproducing equipment has generally consisted of two complete monophonic amplifiers on the same or separate chassis. In single-chassis models, the cost has been slightly greater than that of a monophonic amplifier with equivalent frequency response and total power output. Two new circuits have been devised to eliminate the amplifier for the second channel and thus greatly reduce the cost of stereo equipment for the audiophile. All he needs is a second speaker to convert from monophonic to stereo reproduction.

The circuit developed by CBS-Columbia accepts stereo input signals and reproduces one channel with the output tubes working in parallel and the other channel with the tubes effectively in parallel. This circuit is described in "Two-Way Stereo Amplifier," by Bauer, Bachman and Hollywood, in the December, 1958, issue.

The second circuit is the RCA development described here. Basically, it consists of two single-ended amplifiers operating independently for stereo and as a single push-pull amplifier for monophonic reproduction. This system is used in some recent Victrolas and AM–FM phonograph combinations. These units can be converted to stereo simply by adding another speaker. The block diagram of the RCA two-way stereo amplifier is shown in Fig. 1.

Basic circuit

The cartridge used with the amplifier is phased to deliver equal and out-of-phase signal voltages from stereo and monophonic records. These signals are fed to the grids of preamplifiers V101-a and V101-b. They are amplified by V102 and V103 and appear out of phase at the plates of power amplifiers V104 and V105.

Speakers must operate in phase for satisfactory stereo or monophonic playback so the phase of the output signals in one of the channels is inverted by reversing the primary connections to one of the output transformers. Thus, in-phase speaker operation is obtained from two identical amplifiers with out-of-phase inputs.

Switch S is a part of the function-selector switch connected to corresponding taps on the secondaries of the output transformers. During stereo playback, S is open and the two amplifiers are entirely separate and independent. When S is closed, the trans-

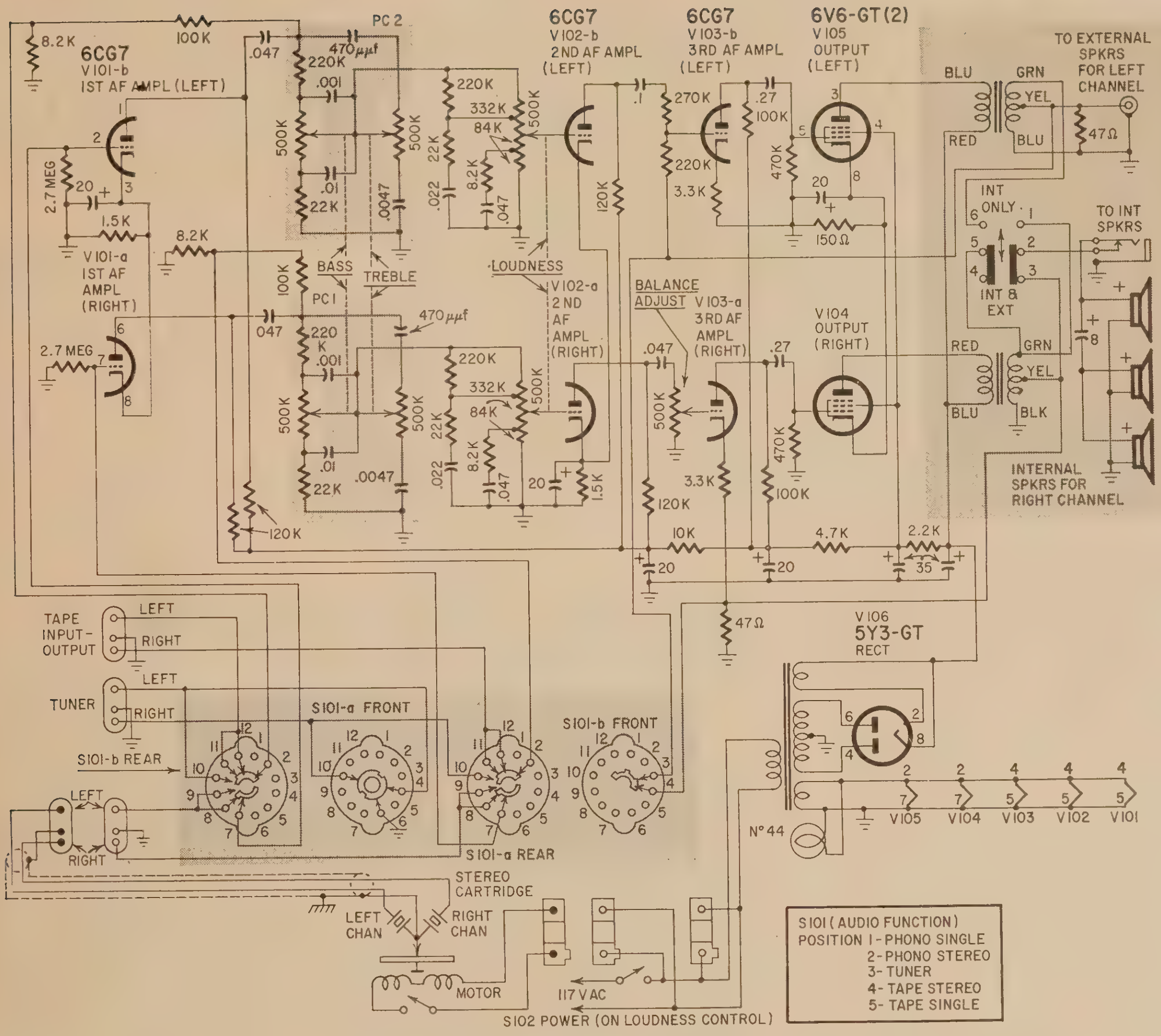

6CG7
V101-b
IST AF AMPL (LEFT)
V101-a
IST AF
AMPL
(RIGHT)
6CG7
V102-b
2ND AF AMPL
(LEFT)
V102-a
2ND
AF
AMPL
(RIGHT)
6CG7
V103-b
3RD AF AMPL
(LEFT)
V103-a
3RD AF
AMPL
(RIGHT)
6V6-GT(2)
V105
OUTPUT
(LEFT)
V104
OUTPUT
(RIGHT)
PC 2
PC1
BASS
TREBLE
LOUDNESS
BALANCE
ADJUST
TO EXTERNAL
SPKRS
FOR LEFT
CHANNEL
TO INT
SPKRS
INT
ONLY
INT &
EXT
INTERNAL
SPKRS FOR
RIGHT CHANNEL
BLU
GRN
YEL
RED
BLK
V106
5Y3-GT
RECT
N°44
V105
V104
V103
V102
V101
TAPE
INPUT-
OUTPUT
LEFT
RIGHT
TUNER
S101-a FRONT
S101-b FRONT
S101-b REAR
S101-a REAR
STEREO
CARTRIDGE
LEFT
CHAN
RIGHT
CHAN
MOTOR
117 VAC
S102 POWER (ON LOUDNESS CONTROL)
S101 (AUDIO FUNCTION)
POSITION 1-PHONO SINGLE
2-PHONO STEREO
3-TUNER
4-TAPE STEREO
5-TAPE SINGLE

Fig. 2—Schematic of the dual-channel amplifier.

former secondaries and speaker voice coils are connected in parallel for monophonic operation. Since the signals at the output plates are out of phase and those at the speakers are in phase, circuit action is essentially the same as for normal push-pull operation with phase inversion taking place in the output transformer instead of some low-level point in the amplifier.

Schematic analysis

The circuit of the unique RS-171 amplifier used in the SHC-8 and SHC-9 stereophonic combinations is shown in Fig. 2. Inputs from the tuner, tape recorder and phonograph cartridge are connected to individual input terminals. The five-position AUDIO FUNCTION switch (S101) selects the desired input and mode of operation. In the PHONO and TUNER positions, the TAPE jacks are connected to the preamp plates and can deliver stereophonic signals to a stereo tape recorder.

The AM-FM turner included in the RCA combinations cannot be used for AM–FM stereocasts. An AM–FM selector switch on the tuner chassis selects either the AM or FM output and feeds it to the amplifier's TUNER input terminals. The selected direct output from the detector is fed to the amplifier's right channel and to the input of a zero-gain phase inverter. (See Fig. 3.) The phase inverter's output is fed into the left-channel input terminal. Thus equal and out-of-phase monophonic signals are applied to the right- and left-channel inputs.

Bass, treble and loudness controls are conventional. Corresponding controls for each channel are ganged, using especially selected potentiometers to insure good tracking. In the left channel, the grid of the second af amplifier (V103-b) is fed approximately half the voltage developed across a voltage divider consisting of 270,000- and 220,000-ohm resistors in series. The corresponding stage (V103-a) in the right channel is fed from the arm of the 500,000-ohm BALANCE control so the outputs of the two channels can be balanced no matter which one is weaker.

Approximately 15 db of negative feedback is applied around the last two

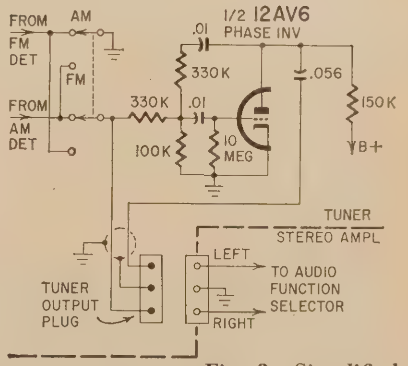

FROM
FM
DET
AM
FM
FROM
AM
DET
1/2 12AV6
PHASE INV
.01
330K
.056
330K
.01
150K
100K
10
MEG
B+
TUNER
STEREO AMPL
LEFT
TO AUDIO
FUNCTION
SELECTOR
RIGHT
TUNER
OUTPUT
PLUG

Fig. 3—Simplified diagram of the input switching arrangement.

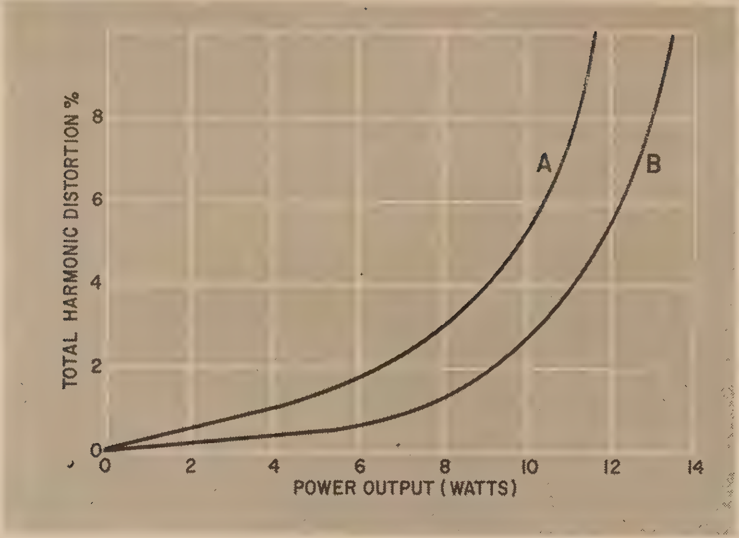


Fig. 4—Comparative distortion curves for dual single-ended amplifiers vs push-pull version.

stages in each amplifier. The voltage developed across the 4-ohm voice-coil taps is 180° out of phase with the signal input to V103-b, so feedback is applied in series with its grid. In the right channel, the feedback voltage and input to V103-a are in phase so the feedback is applied in series with the cathode.

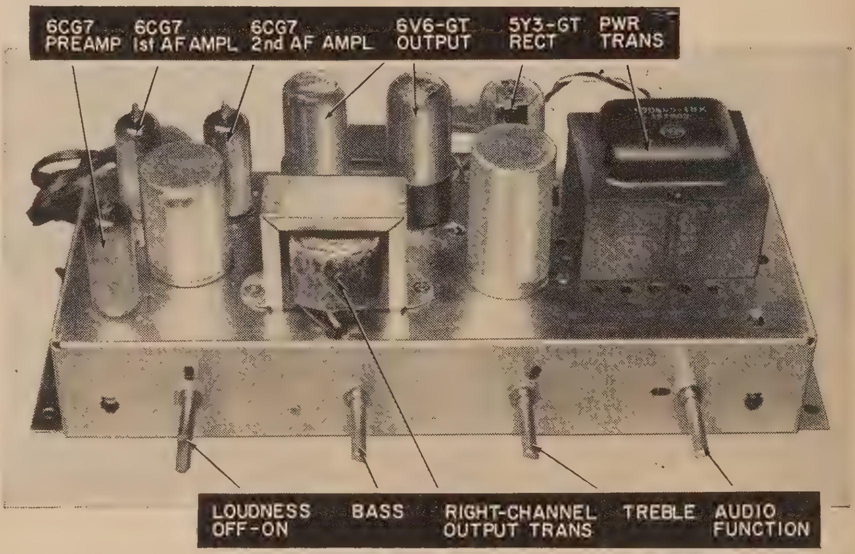
The plates of the output tubes are supplied directly from the rectifier output. Residual ac ripple is high at this point but, since it is injected inside the feedback loop, hum is degenerated by the feedback factor. Furthermore, because hum is in phase on the output plates, it cancels—through phase inversion—in the voice-coil circuit. Thus hum is reduced to a level approaching the result of cancellation in a well-balanced conventional push-pull output stage.

Even-order harmonics generated in the two channels are in phase throughout the amplifiers so they cancel when the voice-coil circuits are paralleled for monophonic operation. Curve A in Fig. 4 shows the power-distortion characteristics for stereo and B shows monophonic (push-pull) performance.

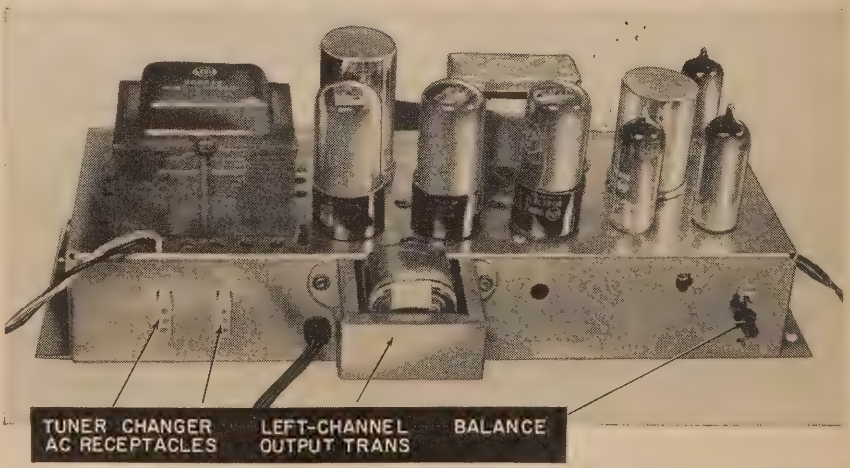
The Victrolas and RCA combinations have internal speakers connected to the right-channel amplifier. A jack is connected across the secondary of the left-channel output transformer for adding the second speaker required for stereo and often desired for monophonic playback. See Fig. 2 for a look at the switching circuit.

When the switch is in the INT ONLY position and no speaker is used in the left channel, both amplifiers are paralleled across and properly matched to the internal speakers. The parallel connection insures that the amplifiers are effectively in push-pull regardless of the position of the input selector.

In the INT & EXT position, the left channel feeds the external speakers. The amplifiers are operated single-ended for stereo and in push-pull—by paralleling the transformer secondaries—for monophonic reproduction. END



RCA uses 6 tubes in their stereo unit.



The balance control and the left-channel output transformer are mounted on the rear of the chassis.

DESIGN YOUR OWN PREAMP

Part II—Tone controls, how they work and how to make them give the results you want

By **NORMAN H. CROWHURST***

At one time tone controls were used for a wider variety of purposes than nowadays, including, for example, compensation for deficiencies in the equalization characteristic. But modern preamps have equalization characteristics which accurately restore the original flat frequency response applied to the recording amplifier in making the recording. Of course this does not mean that the recording and reproduction chain is now perfect.

At the studio end, the system's balance is adjusted according to the judgment of the people responsible for making the recording. The recording studio or auditorium may have excessive brilliance in its reverberation characteristic, causing overemphasis at the high end. It may also produce peculiar effects at the low end, or at any other frequency in the band. Some efforts are made during recording to give satisfactory balance in the recorded program.

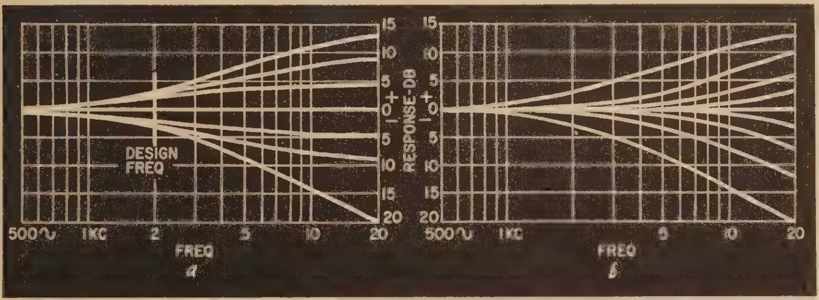


Fig. 1—Two basic methods of altering response with a treble tone control: a—a variable amount of boost or rolloff is applied, beginning at the same frequency; b—the point where boost or rolloff starts is shifted.

However, when this program is reproduced in a living room, the best judgment of balance may not always agree with that determined by the people making the recording. All these things are at best a compromise and the living room in which you reproduce the sound adds further reverberation or acoustic characteristics to the reproduction. This may modify the best compromise for any particular piece of program material in that living room.

This means that a good preamp permits adjusting the comparative response to lower and higher frequencies independent of the equalization characteristic. The first thing to decide is how you want to vary the response at the low and high ends.

High-frequency tone controls

Without going into peaking circuits, there are two ways of varying the response. As referred to the high end, these are illustrated in Fig. 1. At Fig. 1-a, a certain frequency is used as a starting point (500 cycles) and the response may be pushed up or down, from this frequency upward, to a varying degree which is set by the treble control. The other type of adjustment raises or lowers the frequency at which accentuation or rolloff begins (Fig. 1-b).

Fig. 2-a shows a basic circuit designed to give the response variation shown in Fig. 1-a. At the lower end of the spectrum, attenuation in the network is determined by the purely resistive voltage divider, R1 and R2. At the upper end of the frequency response, the reactance of the capacitors brings the potentiometer in parallel with the fixed resistance arrangement and modifies attenuation according to the potentiometer's setting. The frequency at which the change in level begins to have effect is determined by the relation of the reactances of the capacitors to the resistances in the circuit.

To design this circuit we must pick an attenuation that fixes the maximum high-frequency boost we can get. Assume we decide to provide a maximum of 14-db boost. This means the attenuation must be 14 db, or the tapping point on the fixed resistance divider must be one-fifth of the total resistance. So resistor R1 must be four times R2.

So that overall response is level when the pot's slider is one-fifth of the way from the bottom end, the capacitors' reactances should be in the same proportion. C1 should have four times the reactance of C2; or, in capacitance, C2 should be four times C1.

The lower turnover point—the sort of "swivel" point in Fig. 1-a, where maximum boost is 3 db and maximum rolloff 3 db—comes out where the reactance of C1 is equal to the resistance of R1 and the reactance of C2 equals R2's resistance.

Different fixed positions, giving responses similar to those in Fig. 1-b, can be produced by the circuit shown

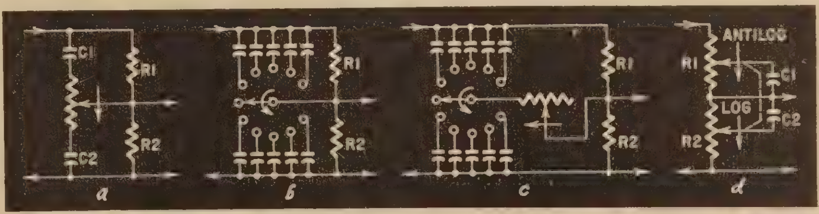


Fig. 2—Basic circuits for high-frequency tone control: a—continuously variable, results like Fig. 1-a; b—fixed steps, results like Fig. 1-b; c—results are combination of Fig. 1-a and Fig. 1-b; d—continuously variable combination of results of Fig. 1-a and Fig. 1-b. Arrows on pots and switches indicate rotation from maximum boost to maximum rolloff.

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*Author: *High-Fidelity Circuit Design* (Gernsback Library).

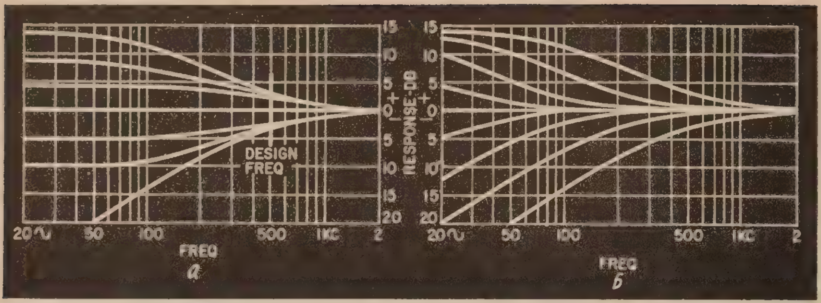


Fig. 3—Two basic methods of varying low-frequency response produce these results.

in Fig. 2-b. It switches a series of capacitors across R1 to produce 14-db boost (using the same values as for Fig. 2-a) starting at different frequencies, or across R2 to produce a rolloff, also starting at different frequencies.

For simplicity, Fig. 2-b shows a single-pole switch with a number of capacitors that connect to either the top or bottom of the R1, R2 combination. Economizing in capacitors by using a 2-pole switch (one pole to select the appropriate capacitor and the other to determine whether the capacitor is connected across R1 or R2) does not work. It is not possible to halve the number of capacitors, because different ranges of values are required for shunting R1 and R2 to get the same range of turnover frequencies for boost and rolloff.

A refinement to this method calls for including a variable resistance in series with the capacitor—or more conveniently in series with the switch arm so that the amount of boost or rolloff can be determined too. This is shown in Fig. 2-c. In effect the circuit combines the responses of Figs. 1-a and 1-b.

A circuit that provides continuously variable boost and rolloff in respect to the frequency at which it starts and the amount is shown in Fig. 2-d. This requires a two-gang potentiometer in which the value of the two resistance elements is in the same ratio as the maximum amount of required boost—say 4 to 1 for a 14-db maximum boost.

For this circuit to operate most effectively, resistance tapers should be complementary. Both can be linear or, preferably, R2 should have a log taper while R1 should have the so-called antilog taper. Under these conditions, when both potentiometers are set to their middle position, response is flat and the capacitors are shunting only about one-tenth of their respective resistance. This makes the frequency range of this kind of control much greater than one using linear potentiometers.

Low-frequency tone controls

Turning to bass compensation, we can produce a similar family of curves by corresponding circuit arrangements. The two possibilities for curves are shown in Fig. 3, and the circuits in Fig. 4. Resistors R1 and R2 provide the basic attenuation for the upper end of the range this time. In Fig. 4-a, C1 and C2 control the turnover frequency and R3 varies the bass boost or rolloff.

R3 should be large compared to R1 or R2. Bass boost or rolloff begins at the frequency where C1's reactance equals R1, and C2's reactance equals R2. The response is, of course, level when the slider is the same fraction up resistor R3 that R2 is of the total R1 + R2. This produces a response variation of the pattern shown at Fig. 3-a.

Fig. 4-b produces a number of fixed responses similar to those shown in Fig. 3-b. Fixed resistors R1 and R2 determine the maximum amount of boost while the 2-pole switch determines which side the capacitors are in and what value capacitor is used.

It is not readily possible, without using inductors instead of capacitors, to produce a circuit corresponding to Fig. 2-d for the low-frequency response. Fig. 4-c shows the nearest approximation that can be made with capacitors. This is because the arrangement that varies the rolloff *frequency*, rather than the *amount*, requires a variable resistance in series with the capacitors instead of in shunt as in Fig. 2-d. This means that attenuation is fixed at the extreme low-frequency end, but variable according to the setting of the control (R1, R2) through the larger part of the low-frequency region, which is what controls how loud the program sounds. Obviously, this is undesirable, but can be offset by introducing a third potentiometer (R3) to produce further attenuation in reciprocal fashion. Now, when the boost-or-rolloff control is set for minimum attenuation (R1, R2, R3), representing maximum rolloff, the additional control (R3) is set for maximum attenuation, and vice versa. To make this work, the range of control must be limited by "bottom-end" resistors or the program would go off at each end position.

The circuit is not altogether satisfactory, because it relies on all of the potentiometers having the right taper for maintaining constant gain over the greater portion of the low-frequency region. The best tapers to use are the semi-log tapers direct and reverse.

Practical composites

Having discussed the various possible controls for a versatile variation of response, the next question is how to incorporate them into practical circuits. As with fixed equalizer networks, they may be inserted between stages of an amplifier or be used as part of a feedback network over a section of an amplifier. From the design standpoint, the forward method is simpler.

The basis for design has already been mentioned as each type was discussed. We will just take a simple design of a composite tone control circuit as an example of how to apply it in an actual circuit. Design can be made ideally simple by feeding the tone control circuit from a cathode follower to give a very low source resistance.

As any tone control causes a loss of gain for the same reason an equalizer does (to provide "headroom" for the boost), additional stages are necessary to make up for the lost amplification. So in this design we'll assume we do not try to use a cathode follower. Using a 12AU7 tube with a 250-volt plate supply, a 47,000-ohm plate coupling resistor, and an 1,800-ohm cathode bias resistor, we get a gain of 14 with a 14,000-ohm effective plate resistance (Fig. 5). This information is obtained from the curves shown in Fig. 6. Assume we have set ourselves a minimum bass and treble boost of 14 db.

The treble boost is cut down, com-

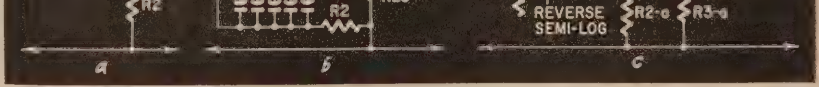


Fig. 4—Some basic circuits for low-frequency tone control: a—continuously variable, results in Fig. 3-a; b—fixed steps, results in Fig. 3-b; c—continuously variable combination of Fig. 3-a and Fig. 3-b, but can only approximate constant mid-band gain and requires three potentiometers.

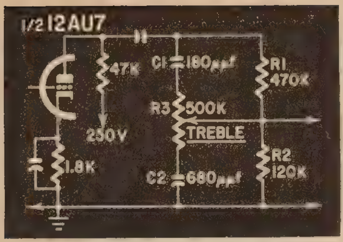


Fig. 5—First part of the design for a composite tone control, showing the values for high-frequency control.

pared with the theoretical value, by the source resistance. This means that the *effective* value of R2 (Fig. 5) for treble boost must include the source resistance, which consists of 14,000 ohms in parallel with 47,000 ohms, about 11,000 ohms. Assume we make R1 470,000 ohms. Then the combination of R2 with the source resistance must be one-fourth of this, or about 120,000 ohms. Deducting the source resistance means that R2 will be satisfactory at 100,000 ohms. But if we use a 500,000-ohm pot for the treble control (R3) it will be effectively in parallel with R2 at maximum boost, so the combination with the 500,000 ohms in parallel should be 100,000 ohms. Well, this brings us back to a value of 120,000 ohms for R2.

Assume that we decide to make the high-frequency turnover point, which will be 3 db up or down, according to whether we use boost or rolloff, at 2,000 cycles. Then C1 will need to have a reactance of 470,000 ohms at 2,000 cycles. A 180-μμf capacitor is the nearest convenient value for this purpose. C2 should have 120,000 ohms of reactance at 2,000 cycles—680 μμf serves well for this position. We have now designed in the values of Fig. 5 for the high-frequency boost and rolloff controls.

What we now need is some provision for low-frequency boost and rolloff (Fig. 7). For the main part of the response, the series resistance of the attenuation circuit consists of R1 plus the source resistance which adds up to 480,000 ohms, while the shunt resistance consists of just R2, which is 120,000 ohms. This produces a 5-to-1 attenuation as required. The boost will occur when R4's slider is at the top end.

To keep most of the full 14-db attenuation, R4 should be the highest value obtainable, because it will deteriorate the maximum boost. Suppose R4 is made 2 megohms. Then the minimum attenuation, at the extreme bottom end of the range, will be produced by 480,000 ohms in series and 2.12 megohms in shunt, which will give almost 2-db loss. This means that the ultimate boost will be 2 db short of the desired 14 db. If you use a 5-megohm pot, this loss will be reduced to less than 1 db. So from this point of view R4 should be the highest value obtainable.

Assuming we want the 3-db boost point to appear at 500 cycles, C4 should have a reactance of 120,000 ohms at 500 cycles. This requires a .0025-μf capacitor. To get a rolloff of 3 db at the same point, C3 must be about 500,000 ohms at 500 cycles, for which a 620-μμf capacitor will serve.

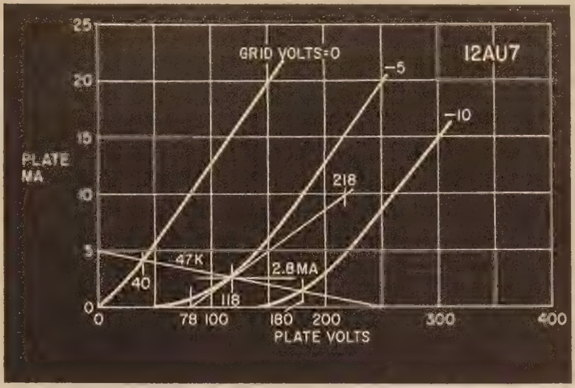


Fig. 6—Part of the curves for a 12AU7, to show the construction on which the figures in the text are based.

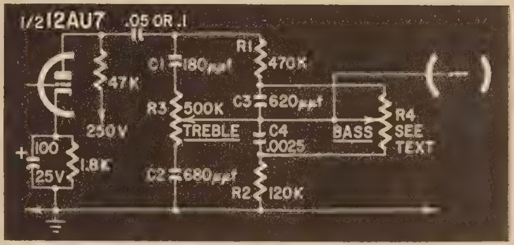


Fig. 7—The circuit of Fig. 5 extended to take care of low-frequency control. The values are calculated in the text.

The complete schematic is shown in Fig. 7. It has to include the coupling capacitor, which should be in the region of .05 or 0.1 μf—this is not critical.

But there is another factor to consider—it may be wise to settle for a value lower than 5 megohms for R4, because when maximum bass boost is used, the grid return for the following stage is 5 megohms, but when minimum bass is used it is only 120,000 ohms. For this reason, it may be wise to settle for the lower amount of boost given by 1 or 2 megohms in this position.

This will not be as serious a loss as may be thought, because bass boost sounds much more effective than a corresponding amount of treble boost, due to the convergence of the sensitivity (Fletcher-Munson) curves of the ear at the low-frequency end. A smaller difference in level makes a bigger difference in apparent loudness.

This procedure illustrates a typical design approach to a tone control for a preamplifier. Some prefer to use variations of combined control of frequency response in the forward amplifier and feedback response control. Theoretically, one could place the network of Fig. 7 in the feedback network and have the control working exactly in reverse—the ends that provide boost in the forward circuit would provide rolloff in the feedback circuit and vice versa.

But there are complications in trying to do this because of phase-shift problems if more than one stage is used. And if only one stage is used, the problem is getting workable resistance values that will not load the stage gain down.

The next step in tone controls is a study of the feedback types. As this is a rather more complex subject it will be treated in an article of its own at a later date.

TO BE CONTINUED

DON'S
TV
SERVICE
DEMCHUCK

"No, this isn't Don. Your set is smoking . . ."

new DISCS and TAPES

Reviewed by

Chester Santon

Station WQXR
New York City

STEREO and MONO

THE roster of companies releasing recorded tapes now boasts an interesting new entry. Material from the huge London Records catalog will now be available on four-track open-reel tapes. London thereby becomes the first influential record firm to throw its support behind the 7.5-ips quarter-track format. The audiophile should soon be able to find any popular recording he chooses in either the disc or tape stereo medium.

High Spirits
Audiotape Special Offer (2-track, 7.5 ips) (7-inch; playing time, 28 min.)
***Technical Rating:* EXCELLENT**

The latest bonus reel issued by Audio Devices, Inc. is aimed at the three present forms of open-reel playback in the home. A 1-hour version of this recording is available on both dual-track mono and four-track stereo. This two-track stereo reel offers ½ hour of music. I tried the two-track stereo version first because their last promotional effort reviewed a few months ago was two-track. There is a perceptible improvement in the sound of *High Spirits* with a cleaner bite whenever the wave gets steep. Response is smoother throughout the frequency range. Following the example of the previous tape (*Blood and Thunder*), no attempt has been made to saturate the recording surface with a level of the highest-possible decibel count. Some outfits have been known to resort to this to mask the tape hiss that followed the use of inferior tape stock or carelessness in the dubbing process. The *High Spirits* theme of this collection comes from careful selection of music of an optimistic nature. A seldom-heard Johann Strauss march sets the mood. Then follows lilting music from the same composer's *Die Fledermaus.* The final movement of Beethoven's first (and lightest) symphony and sections of Tchaikovsky's *Capriccio Italian* and Bizet's *Suite from Carmen* take us to the reel's climax—the blazing *Rakoczy March* by Berlioz. The hour-long version of this recording retains the same first and last selections, but offers more extended samplings of the remaining works heard on this reel. I was surprised to discover that the four-track version stands up very well in the company of the two-track stereo. Signal-to-noise ratio is quite similar. The difference in background was spotted at only one area, soft passages in the Beethoven symphony. The noise level there was a shade higher than that on the two-track. Lows are about equal on both reels and the four-track has enough upward tilt at the high end to bring it in line with the two-track job. The familiar advantages of tape in locating the instruments is equally evident in each reel.

Guitarra de Venezuela
Alirio Diaz, guitar
Hi Fi Stereo Record R 812
***Technical Rating:* ?**

Two years after the introduction of the stereo disc, the problem of phase still awaits solution on some labels. This particular record sounds better with the stereo preamp phase-reversal switch in the position opposite to that used for normal, correctly phased stereo material. Some variables are present in playback, but in the case of this solo guitar record most listeners will find their suspicions aroused when they first hear it on two channels that are in phase. On such a system, the guitar may appear to have a ludicrously wide source of sound. At any rate, I discovered that a flick of the phase-reversal switch into opposite position focused the sound to a reasonable area between speakers, improved the clarity and helped the lower register of the instrument. Only then was I ready to enjoy an excellent recital for classical guitar as played by Señor Diaz.

HANDEL: *Messiah*
Sir Thomas Beecham conducting Soloists, Royal Philharmonic Orchestra and Chorus
RCA Victor Stereo Records (4) LDS-6409
***Technical Rating:* EXCELLENT**

For many months RCA Victor has been preparing a special series of recordings under the supervision of Dario Soria, who established Angel Records in this country before joining RCA. The highlight of the first release in the Soria series is a new version of Handel's choral drama *Messiah* conducted by Sir Thomas Beecham. I haven't heard the other recent stereo versions of Handel's greatest oratorio, but this album is one of the most impressive recording jobs I've encountered in my years of listening. Anyone considering the purchase of this recording for playback on a good system is hereby warned that most choral stereo discs in his collection will sound either tinny or tame after this one. In his highly personalized treatment of the score, Beecham stresses the color and excitement in the sound of the orchestra. The depth and liveness of the stereo illusion lifted me out of my chair when chorus and orchestra reached the first full-volume moment in the intense dynamic range.

TCHAIKOVSKY: *Symphony No. 6 in B Minor*
Vladimir Golschmann conducting Vienna State Opera Orchestra
Vanguard Demonstration Stereo Disc SRV-112SD
***Technical Rating:* EXCELLENT**

In the past, Vanguard's Stereolab demo records have offered virtually all the technical refinements of their full-price line. No exception to the rule, this version of the Tchaikovsky sixth, priced at $2.98, enjoys considerable advantage over earlier recordings of the *Pathètique.* The latest cutters are capable of cleaner sound, and stereo directionality is far more pronounced. Other orchestras may have more power in the way they play this score, but Vanguard has a whale of a record at an irresistible price.

VANGUARD
STEREOLAB
A UNIQUE STEREOPHONIC DEMONSTRATION DISC
TCHAIKOVSKY
SYMPHONY NO. 6 "PATHETIQUE"
IN B MINOR
VLADIMIR GOLSCHMANN

The Dukes at Carnegie Hall
Audio Fidelity Stereo Record AFSD-5918
***Technical Rating:* GOOD**

The Dukes of Dixieland chalk up their tenth release for Audio Fidelity on the stage of Carnegie Hall. This recording of the affair opens with an instrumental warmup on *Royal Garden Blues.* Then the audience in the hall has a chance to be heard. As each member of the band is introduced, he identifies himself with a few measures on his individual instrument while acknowledging the applause of the crowd. Although the Duke's familiar brand of Dixieland enjoys greater freedom on stage than it has under studio conditions, the job of the engineering staff was not made easier. Control of sound is adequate. In addition to reliables such as *Muskrat Ramble* and *Sweet Georgia Brown,* the bill of fare highlights the trombone in *Slide Frog Slide* and *76 Trombones.*

Giant Wurlitzer Pipe Organ, Vol. 6
Leon Berry
Audio Fidelity Stereo Disc AFSD-5904
***Technical Rating:* EXCELLENT**

Here's another signpost of technical progress in the stereo disc. Leon Berry fans familiar with the ultra-close miking pickup used in his monophonic releases may be interested to learn that this technique has now been successfully transferred to dual-channel discs. The playing still has a lumbering style, but the sound is clean-cut. Most of the tunes are old standbys such as *Avalon, Moonlight and Roses* and *Darktown Strutter's Ball.*

Swingin' Round the World
Jonah Jones Quartet
Capitol Stereo Record ST-1237
***Technical Rating:* EXCELLENT**

With the audacious trumpet of Jonah Jones blazing the trail, the traveling is light in this musical tour of the globe. Muted or full, Jonah's horn takes his group into each country with nonchalant ease. The tunes, however, seldom depart from the Tin Pan Alley level.

***Take Me Along* (Original Cast Recording)**
RCA Victor Stereo Record LSO-1050
***Technical Rating:* FAIR**

This new Broadway musical based on Eugene O'Neil's play "Ah Wilderness" stars Jackie Gleason, Walter Pidgeon and Eileen Herlie. With the aid of Robert Merrill's music and lyrics, they translate into sound the starched-collar atmosphere of a small Connecticut town in the year 1906. Unfortunately, the acoustics jolt the listener into the present. Someone decided that the studio sound wasn't live enough to carry out the illusion of stage presence on a portable phonograph. The dosage of artificial reverberation introduced is too much for my equipment under normal playback curve. Much of the boominess, however, can be melted with sufficient rolloff in the bass end.

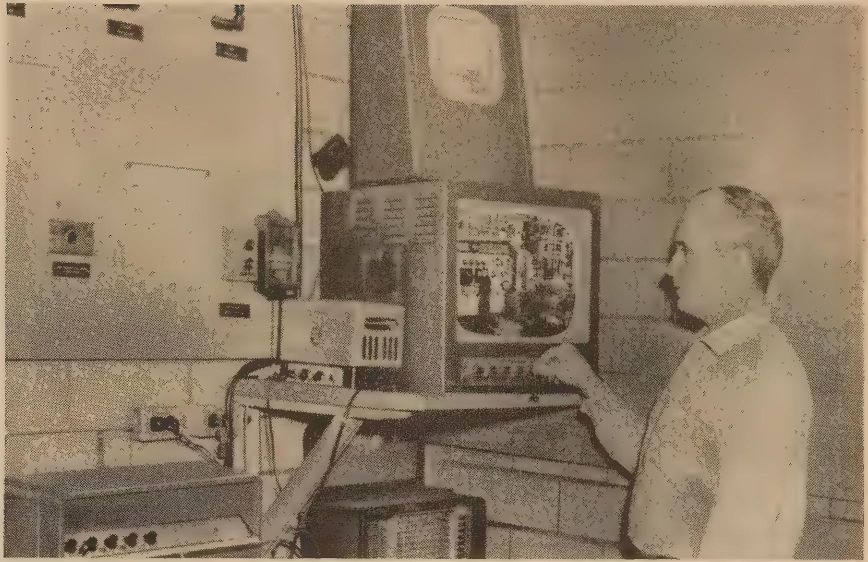
Note: Following record is a 12-inch mono LP and plays back with RIAA curve.

British Band Classics, Vol. 2
Frederick Fennell conducting Eastman Wind Ensemble
Mercury MG 50197
***Technical Rating:* EXCELLENT**

Admirers of Mercury's first album of band classics from England are already aware of the foundation-shaking possibilities of this series. Vol. 2 will not disappoint them. In Walton's *Crown Imperial March,* the large pipe organ of the Eastman Theater lends its voice to the thunderous sonorities of winds and percussion. Gordon Jacob's setting of 16th century tunes by William Byrd, recorded for the first time, may prove a bit esoteric to some band enthusiasts, but this early music does lend a fresh flavor to Fennell's smart wind group. If your system loafs along at its full output, this one's a jimdandy to play. END

Name and address of any manufacturer of records mentioned in this column may be obtained by writing Records, RADIO-ELECTRONICS, *154 West 14 St., New York 11, N.Y.*

ITV Lens and Lighting Systems



Shift foreman at Esso Research & Engineering Co. pilot plant at Bayway, N. J., checks safety of workmen on job at unit 300 feet away via General Precision Labs closed-circuit TV system.

By **EDWARD M. NOLL**

LIGHT and lenses are important factors if you want a good quality picture from an industrial television system. Last month we learned of the importance of careful camera tuning. The same thoughtful attention should be given to the choice of camera lens, camera placement and lighting.

Camera placement is important. Experiment before deciding on a final mounting position. An optimum compromise should be made between mounting position, information to be conveyed and available lighting. The mounting position should be so selected that it does not interfere with the operation of the device being observed or with regular traffic activities in the plant or business establishment.

The camera should be rigidly mounted and the mount used must withstand whatever temperature or weather variables exist. Many special mounts are available. There are explosion-proof mounts as well as completely weatherproofed ones for outdoor application. Special mounts for microscopes, data pickup and other instrumentation uses are available. One of the most versatile is the motor-controlled pan and tilt arrangement. With such an installation the camera can scan a given area and be tilted up and down from a remote master viewing position.

All these factors should be considered by the installer and made known to the potential owner of an industrial TV system. The owner may want a camera for one particular operation. However, other tasks can also be handled by the installation if the mounting positions and mounting devices are chosen carefully. Always keep this in mind and bring it to the owner's attention as you survey the area in which the installation is to be made. For example, a camera may be needed to observe a particular confined operation during the plant's operating hours. However, there is no reason why the same camera can't be used for plant surveillance and protection at night.

A closeup lens can be used to pick up the specific industrial procedure during plant operation and a wide-angle lens can be switched in at night. Then proper pan and tilt adjustments can be made so the camera covers a much larger area for surveillance.

In some installations, it may not be possible to use supplemental lighting and it may be necessary to pick up a picture with a low ambient light level. Under these conditions, the camera should be mounted close to the monitored area to make full use of whatever light is available. A fast, high-sensitivity lens is a necessity. Of course, the lens iris should be opened wide to admit as much light as possible. In other installations the camera may face a flame, molten metal or other intense light source. If this happens, use neutral-density filters in front of the light source or camera lens to cut down the light level. It is usually better to put the filter in front of the light source so adjacent objects will be reproduced with better contrast.

Lenses and their characteristics

The choice of lenses for a given industrial television application is a function of a number of factors. Lens diameter and focal length must be chosen to produce an image on the very tiny photosensitive area of the vidicon target. The lens chosen must render the proper field of view and depth of focus to include all the desired material in the picture. The desired viewing area should fill the useful picture area to produce a discernible and high-resolution picture.

To understand more clearly how a wise lens choice can be made, let us consider the four major characteristics of lenses: focal length, lens speed, field of view and depth of focus. The focal length of a lens, as shown in Fig. 1, is the separation between the optical center of the lens and the point where the parallel rays come into focus. With the proper focal length, the desired subject or viewing area produces an image that just fills the target area of the vidicon tube. In turn, the image on the monitor screen just fills the picture-tube raster in the same proportion. The focal length of a lens is designated by a capital F (not to be confused with f, which we shall meet later). The greater the F number, the wider the separation between lens and vidicon and, therefore, the greater the physical length of the lens barrel.

Actually, the F of a lens determines image magnification and the field of view that can be covered. A large-F lens gives a better closeup view of a

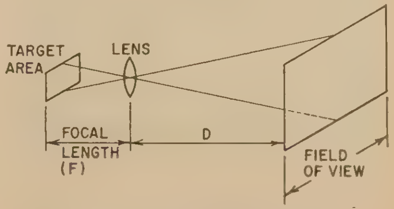
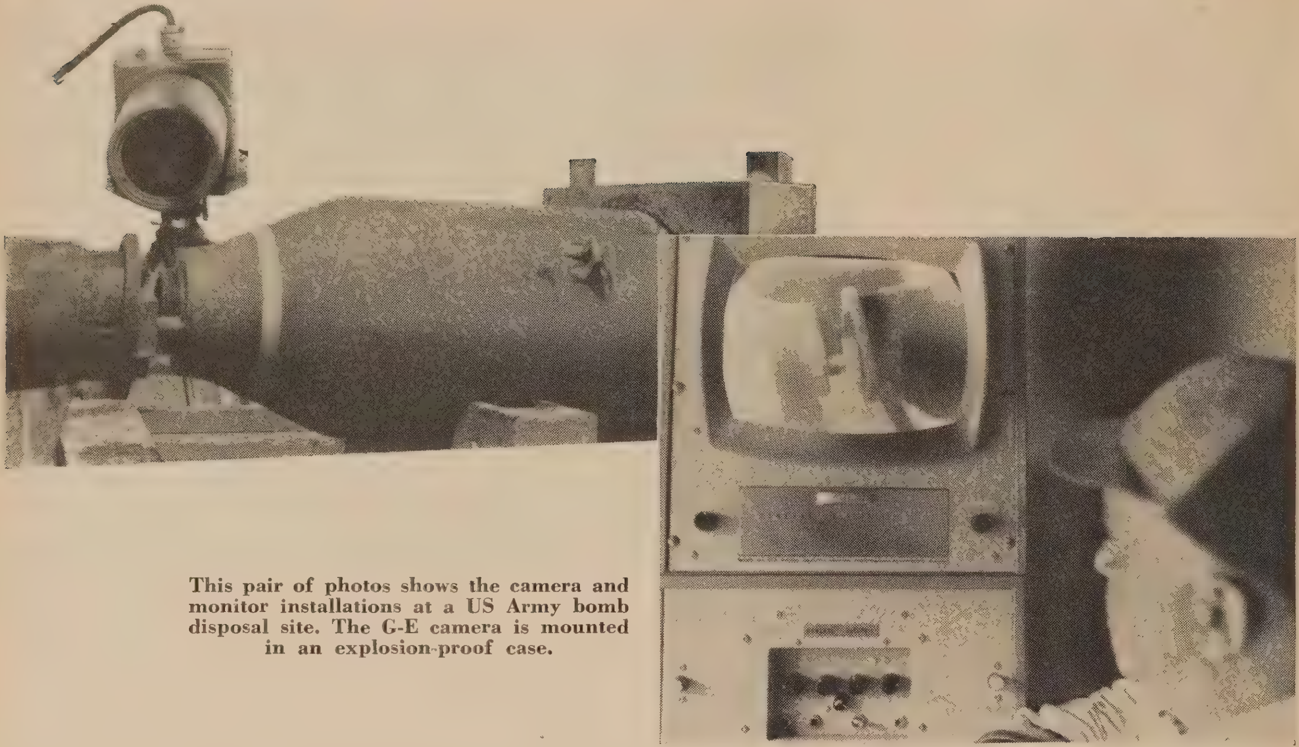


Fig. 1—Simple diagram shows lens characteristics.



This pair of photos shows the camera and monitor installations at a US Army bomb disposal site. The G-E camera is mounted in an explosion-proof case.

distant object. However, the horizontal and vertical viewing fields of a large-F lens are smaller. This relationship can be best shown by the chart in Fig. 2.

The chart indicates the horizontal field of view (width) at various distances from the lens in terms of the focal length of the various standard lenses that can be employed in industrial television service. Notice the field of view for a 1-inch lens at 20 feet is 10 feet wide. A 2-inch lens has only a 5-foot field of view at 20 feet. The

$$\frac{F}{\omega} = \frac{D}{W}$$

$$W = \frac{D\omega}{F}$$

$$W = \frac{20 \times \frac{1}{2}}{2} = 5 \text{ feet}$$

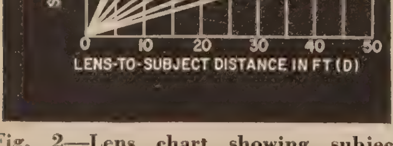


Fig. 2—Lens chart showing subject distance and field of view. Characteristic lines for several lenses are shown.

relationship can be stated as a formula: where W equals subject width in feet, D equals lens-to-subject distance in feet, ω equals vidicon target width in inches, and F the focal length of the lens in inches.

Target dimensions of the vidicon tube are ½ inch wide by ⅜ inch high, establishing the standard 4-to-3 aspect ratio. As a result, the vertical field of view is actually three-fourths of the value indicated on the chart and as calculated in the previous example. For example, the vertical field of view with the calculated horizontal field of view of 10 would be 7.5 feet. For a horizontal field of view of 5 feet, the vertical field would be 3.75 feet. Typical fields of view for the 1-, 2- and 3-inch, etc., lenses are shown in Fig. 2.

In other words, choose a lens whose focal length can accommodate the field of view desired at the prescribed distance from the camera. The installer, with the help of a lens chart, determines what type of lens to use to cover the desired area with relation to the camera mounting position.

Lens speed also has great significance. Lens speed is indicated by a small f number and is related to the focal length and lens diameter:

$$f = \frac{F \text{ (focal length)}}{D \text{ (lens diameter)}}$$

A large-diameter lens admits more light, is more sensitive and is said to be faster. The cost of a lens increases with its diameter because of the complex grinding processes. In industrial TV applications, another limiting factor to the use of large diameter lenses is the small size of the target area.

The formula indicates: **the smaller the f number the more sensitive the lens.** Consequently, more light is delivered to the vidicon target using a lens with a small f number. This is a very important consideration in obtaining a picture of good contrast and low noise content. A small-f lens is mandatory at low ambient light levels.

The formula also indicates that the shorter the focal length of a lens of a given diameter, the higher the speed and the smaller the f number. In terms of lenses of approximately the same diameter, the longer-focal-length types generally have the higher f number. In other words, under difficult lighting conditions, it is best to choose a lens with a small f number and a short focal length. Remember that the short focal length indicates that for a given field of view the camera can be positioned nearer to the area to be televised.

The usual lens mounting arrangement for an ITV camera includes an iris adjustment ring which is calibrated in f numbers and a focusing ring which is used to position the lens properly with respect to the target area to bring the given televised area into correct focus. The adjustable iris is in the form of a diaphragm which can be used to vary the lens' effective diameter. The actual diameter of the lens is the value obtained with the iris wide open. For a very bright scene the iris can be closed down, reducing the effective lens diameter. As a result, the sensitivity of the lens is reduced but there is a greater depth of field.

The final lens characteristic of importance is depth of field. The depth

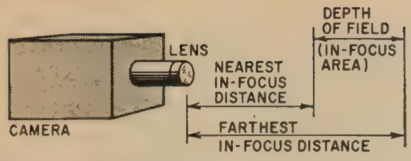

DEPTH OF FIELD (IN-FOCUS AREA)
LENS
NEAREST IN-FOCUS DISTANCE
CAMERA
FARTHEST IN-FOCUS DISTANCE

Fig. 3—Depth of field is in-focus area covered by ITV camera.

of field, as shown in Fig. 3, is the distance from the nearest point of sharp focus to the farthest point of sharp focus. A lens system must be chosen that permits the nearest significant object in the televised area to be in focus as well as the farthest object.

A number of procedures can be followed to increase the depth of field. The depth of field is greater with a shorter focal length lens. It is greater with a slower lens (larger f number), and a greater separation between the object and the camera for a lens of a given f number. If a lens has an iris adjustment, depth of field can be increased by stepping down the iris to a smaller aperture. An iris is stepped down by adjusting it to a higher f number (smaller opening). Of course, this means that less light is admitted and is certainly not advisable at low ambient light levels. However, with abundant light available, the depth of field and picture quality can be improved by stepping down the iris setting.

It is always advisable to limit illumination to the vidicon camera tube to 200 foot-candles. In this way, the camera tube can be operated under its most favorable conditions. When light levels exceed 200 foot-candles, the lens system can be adjusted to reduce the light and increase the depth of field and magnification of the area observed. At low light levels, compromise techniques must be employed. Generally, the most sensitive lens arrangement must be employed—a short-focal-length lens of high speed, lens iris wide open, and camera positioned as close to the televised area as possible to include the important information to be conveyed in focus.

Lighting considerations

In most ITV installations there is no objection to supplemental lighting when needed. Properly positioned lights above and to the side of the camera can do much to give a picture with superior contrast and improved definition. Many TV cameras include special wide-band video facilities. With abundant light available, the video amplifier can be switched to a wide-band position. This increases the system's frequency response and produces a picture with better resolution.

When the video amplifier system is operated in the wide-band position, the system's overall gain is reduced and, in some cases, the noise content is increased. As a result, abundant lighting must be available to generate a video signal capable of overriding the circuit noises and strong enough that, with the gain available, a picture of full contrast can be developed on the screen of the monitor. At low ambient light levels narrow-band operation of the video amplifier is preferable. The video gain is greater and the noise content lower. Hence, there is maximum amplification of whatever video signal level is made available at the camera tube's output.

Light levels are generally measured in foot-candles. For best results, the vidicon camera tube requires some 30 to 200 foot-candles. Below 15 to 20 foot-candles the picture develops some grayness and is not as clear and sharp. Very bright objects in the scene have a tendency to stick or smear. Lighting in excess of 200 foot-candles makes no noticable improvement and, if this much light is available, the lens system can be stopped down for additional optical advantages.

Light meters are available to measure the incident light directly in foot-candles. Such meters are commonly employed by amateur and professional photographers. The best method to measure light levels is to position the light meter near the subject to be viewed and point it in the direction of the camera location.

Always keep in mind, to avoid damaging the target surface, not to point the camera directly either at the sun or any intense source of light. Try to arrange the installation so the bulk of the available lighting is above or to the side of the camera mounting position. Either fluorescent or incandescent lighting can be employed. Sometimes the combination of both aided by daylight from a window, determined by the color range of the material to be televised, renders the best picture. In other cases one may be better than the other. In the transmission of objects with color ranges largely in the red region, incandescent lighting will often provide the best operating condition in terms of picture and necessary lighting power. When the objects range over the entire color spectrum or are concentrated in the blue region, fluorescent lighting is preferable.

In general, the background should never be as bright as the main object or objects to be viewed. Normally, white and glossy backgrounds should be avoided.

In most industrial TV installations the area to be covered is small (generally no more than 20 feet in diameter and in most cases considerably less). As a result, simple reflector or projector type lamps can be easily installed either individually or in banks. Standard fluorescent lights and fixtures can also be employed conveniently.

Many reflector and projector lamps have front surfaces formed into a lens so that specific spot or flood patterns can be obtained. It is surprising how many foot-candles of light can be added using very simple and inexpensive lamp installations.

The chart shows the number of foot-candles that can be contributed by rather low-wattage lighting. The chart indicates available foot-candles as a function of distance between light and objects in terms of lamp wattage and type.

When very small areas are to be televised in data pickup service, miniature fluorescent lamps are often advantageous because of their cooler light. Daylight fluorescents generally render the best reproduction when a wide range of colors are represented in the information to be televised.

The installer of an industrial television system must have some knowledge of lenses and lighting. With this knowledge he can get a high-quality picture under favorable lighting conditions and make certain that practical and usable pictures can be obtained under more adverse conditions of television pick-up. END

LAMPS VS LIGHT OUTPUT

	Distance in Feet				
Reflector Lamp	5	10	15	20	30
75-watt spot	60–80 foot-candles 1-ft spot	15–20 foot-candles 2-ft spot			
75-watt flood	12–20 foot-candles 2-ft spot				
150-watt spot	200–275 foot-candles 1-ft spot	50–70 foot-candles 2-ft spot	25–35 foot-candles 3-ft spot	15–20 foot-candles 4-ft spot	
150-watt flood	44–50 foot-candles 2-ft spot				
300-watt spot	500–660 foot-candles 1-ft spot	120–160 foot-candles 2-ft spot	40–50 foot-candles 3-ft spot	35–40 foot-candles 4-ft spot	15–20 foot-candles 6-ft spot
300-watt flood	80–110 foot-candles 2-ft spot	22–29 foot-candles 5-ft spot			

PHOTOELECTRIC REGISTER CONTROLS ...*how they work*

Part II—Details of cutoff register systems. Troubleshooting and servicing controls

By **ALLAN LYTEL**

THERE are two basic kinds of register controls—the *side register control* was described last month. This time we will examine the *cutoff register control.* Fig. 1 shows one version of this type of control. The web with the register marks passes through the cutting machine. As it passes under the web scanner, each register mark produces a signal pulse. The cutter, several feet from the phototube, controls the cutting edge and a rotating switch.

When the cutter and register marks are in sync, there is no correction output. This is shown in Fig. 2. The rotating section (selector switch) makes one revolution for each time the cutter does its job. If the cutter and register marks are in sync, the phototube signal arrives when the switch is open and has no effect. However, if the phototube signal is late (when the cutter leads), it is passed through the switch to point C and on to thyratrons that control the drive motor to slow it down. If the phototube signal is early (the cutter lags), the phototube signal passes through the switch to point B and the drive motor is speeded up.

CR7515-W210 cutoff register control

This system is shown in the schematic and Fig. 3. It continuously maintains register between a cutter and the material being cut on any continuously fed cutoff machine. This is done by the control panel which compares electronically the register-mark signal from the scanning head and the cutter-position signal from a selector switch. Any error signal produced by the comparison changes the field current of the pilot generator (which supplies power to the correction motor). Since the generator is driven from a machine at a speed proportional to the material speed, the system compensates automatically for variations in machine speed.

In this system, the correction motor runs in only one direction and errors are corrected by changing its speed from

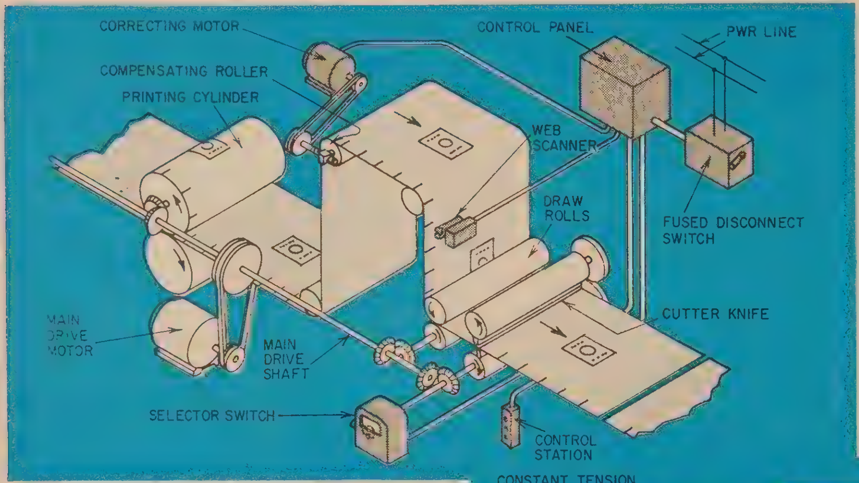

CORRECTING MOTOR
COMPENSATING ROLLER
PRINTING CYLINDER
CONTROL PANEL
PWR LINE
WEB SCANNER
DRAW ROLLS
FUSED DISCONNECT SWITCH
MAIN DRIVE MOTOR
MAIN DRIVE SHAFT
CUTTER KNIFE
SELECTOR SWITCH
CONTROL STATION

Fig. 1 (above)—Motor-driven compensating roll changes position of web with respect to cutter by changing the length of paper between the printing and cutting processes.

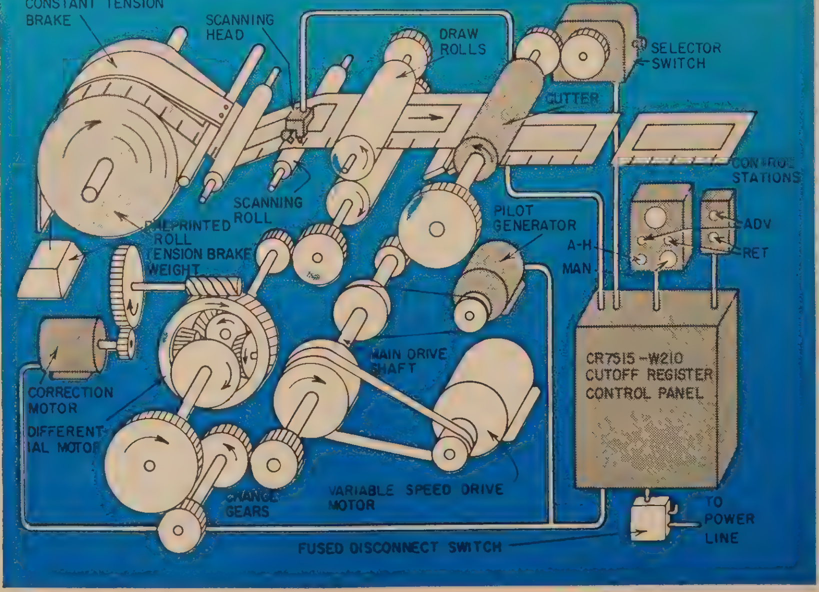
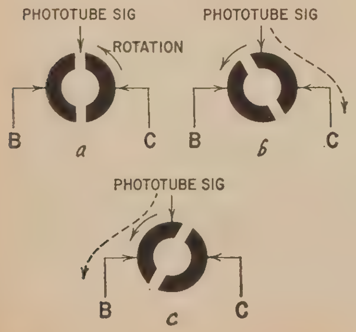

CONSTANT TENSION BRAKE
SCANNING HEAD
DRAW ROLLS
SELECTOR SWITCH
CUTTER
CONTROL STATIONS
SCANNING ROLL
PRINTED ROLL
TENSION BRAKE WEIGHT
PILOT GENERATOR
A-H
MAN
ADV
RET
MAIN DRIVE SHAFT
CR7515-W210 CUTOFF REGISTER CONTROL PANEL
CORRECTION MOTOR
DIFFERENTIAL MOTOR
CHANGE GEARS
VARIABLE SPEED DRIVE MOTOR
TO POWER LINE
FUSED DISCONNECT SWITCH

Fig. 3 (right)—Typical application of CR7515-W210 photoelectric cutoff register control system.

Fig. 2 (below)—How selector switch produces error signal.


PHOTOTUBE SIG
ROTATION
B
a
C
PHOTOTUBE SIG
B
b
C
PHOTOTUBE SIG
B
c
C

the preset value or base speed. Actual motor speed is usually lower or higher than its base value so two-way operation is possible without reversing the motor.

Material is normally fed into the machine at a speed slightly higher than required. Then the proper rate of speed is set by selecting the base speed of the motor so it reduces overfeed until the material and the cutter are in register.

The system corrects continuously for any deviation in position between the material and the cutter by either increasing or decreasing motor speed from its base value, thus feeding the material slower or faster to keep it and the cutter synchronized.

The selector switch, which is geared to the cutter, produces a signal which indicates the cutter's position. This switch contains two phototubes, an amplifier tube and a light-source lamp. A disk that rotates inside the selector switch contains six pairs of slots. These slots permit light to strike the phototubes as they pass in front of them. This produces the cutter-position signals (leading and lagging), which are amplified and sent to the control panel. The control will operate for web speeds of 20 to 750 feet per minute and with one to six register marks per cut.

While the control can detect errors as small as .005 inch, the accuracy of the cut depends upon such other factors as register-mark spacing, backlash in the gearing, loose couplings, tension control of the web, etc. With an average machine, accuracies of ± 1/32 inch are expected, provided the register marks are equally spaced and web tension is reasonably controlled. With an exceptionally good machine and close control over the other variables, accuracies of ± 1/64 inch can be obtained.

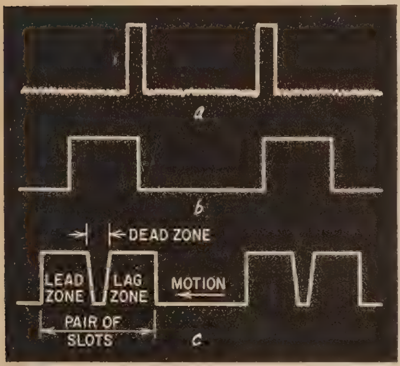


Fig. 4 — Waveforms from: a — web scanner; b — selector switch leading or lagging zones; c—selector switch.

Register-mark scanner

This unit looks at the register marks printed on the material. The phototube observes the material as it passes a focused spot of light. When a mark passes the light spot, a change of intensity is noted by the phototube, then amplified and sent to the main panel. In this way the position of the material is noted. The scanner operates on either light increase (light mark on dark background) or light decrease (dark mark on light background) simply by setting a toggle switch on the scanner. The output waveform is shown in Fig. 4-a.

Selector switch

The position of the knife or other device working on the material is registered by the selector switch. Two signals are developed: one before the knife cuts (leading zone), and one after the knife cuts (trailing zone). This is done by gearing the unit to the knife so a slotted disk inside the unit revolves with the cutter. On one side of the disk are two phototubes. On the other side is a light source. The slots are arranged so light strikes first one and then the other phototube, thus creating two signals which are amplified and sent to the control panel. An adjustment inside the unit allows the two zones to overlap (light falls on the trailing phototube before leaving the leading phototube) or to have a dead zone (light falls on neither phototube).

Selector waveforms are shown in Fig. 4-b as the signal from *either* the leading or lagging zone. Fig. 4-c shows selector waveforms and indicates the lead and lag zones.

Register mark indicator

Going back to the schematic, V2, a 6E5 indicator, mounted at the top of the panel, indicates incoming register-mark signals. By observing V2, one can see when a register mark is detected by the sudden widening of the shaded area.

Dc bridge

A network of resistors placed between the positive and negative dc buses supplies various voltages necessary for the operation of the panel. These voltages are adjusted by setting slides on the resistors.

Discriminator

In this circuit the positions of the knife and paper are compared. V3 and V4 have two controlling grids; one takes its signal from the register-mark scanner and the other receives its signal from the selector switch. Two tubes are required because there are two selector switch signals, one for the leading zone and one for the trailing zone. The two grids in each tube are normally operated so that no current flows unless a positive signal appears on both grids at once. When the material is in register, both discriminator tubes produce signals or both remain cut off, depending on the adjustment of the dead zone in the selector switch. When the material is out of register, only one tube produces a signal.

Error detection

This stage detects the difference between the precise setting of the cutter knife and the position of the register marks.

Motor control

The normal running speed of the correction motor for a particular machine speed is controlled by the base-speed potentiometer. If the material is in register, correction-motor speed is normal. However, if there is an error, the correction motor runs either faster or slower, depending on the signal coming from the stability network.

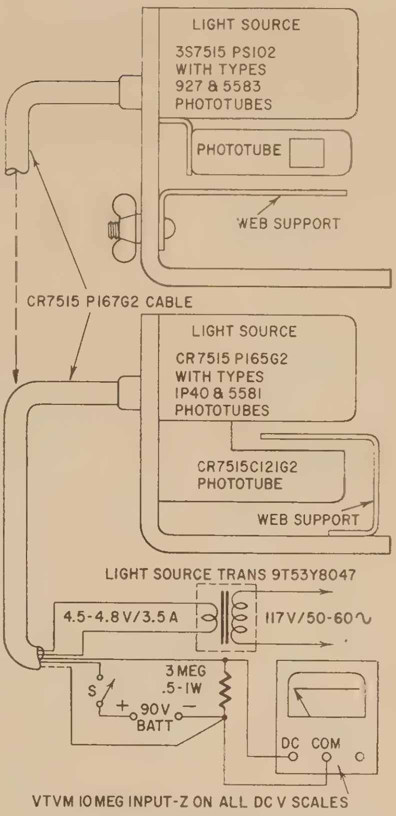


Fig. 5—Register sample tester.

Current through the generator field is regulated. When in register, current is at a value determined by the base speed setting. When an error is detected, field current is varied to correct motor speed. There are advance and retard pushbuttons for changing register while the machine is running.

Servicing techniques

Cutoff register controls

A sample tester, shown in Fig. 5, tests samples of register marks on a web to determine the output signals from the motor control. Two register controls are shown. The samples are set up so that the operating conditions are as close to actual use as possible. A light-source transformer with a 4.5- to 4.8-volt output is required.

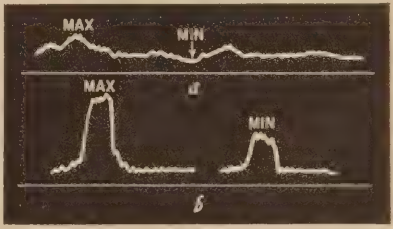
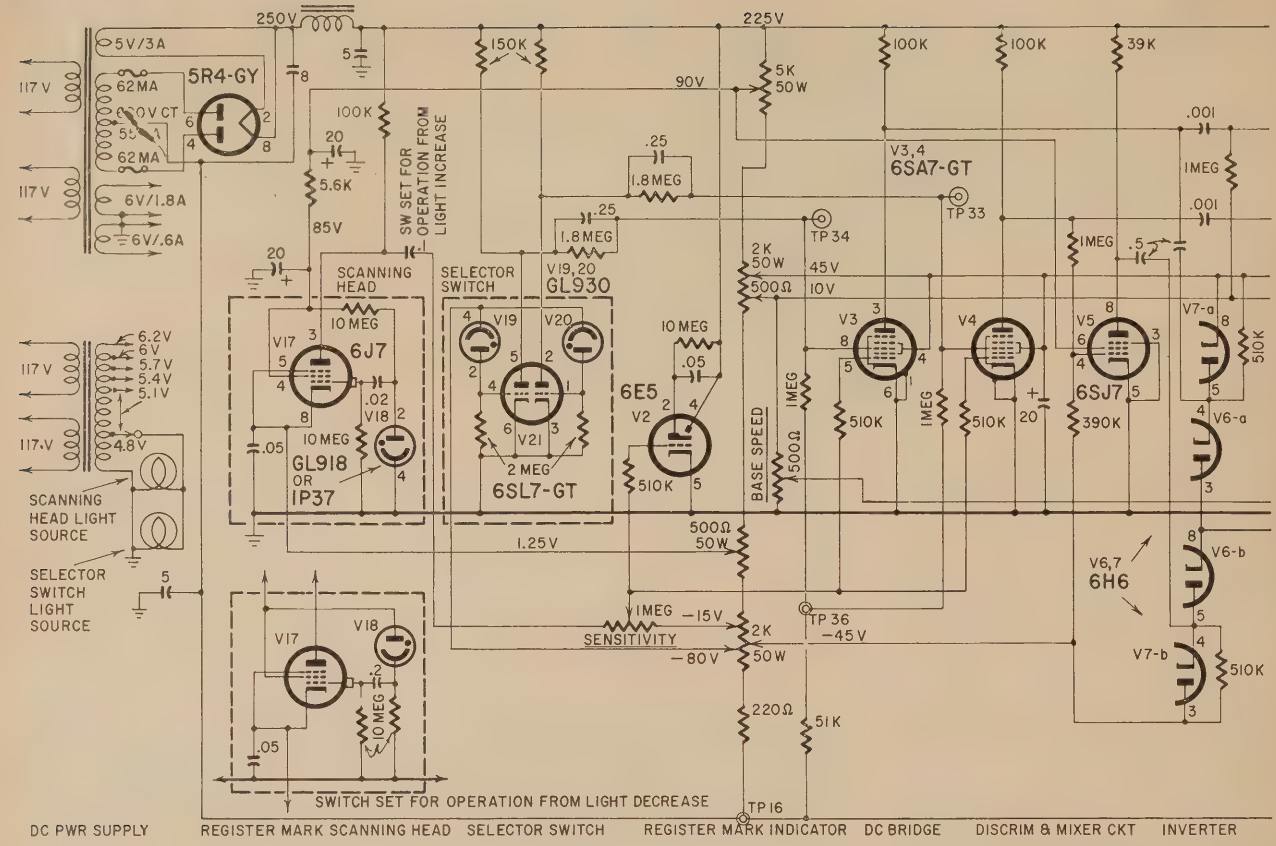


Fig. 6—Characteristics of web (a) and register-mark (b) variations. Register marks must have at least 20 times the amplitude of web variations.


250V
225V
117 V
5V/3A
62MA
5R4-GY
650V CT
550V
62MA
6V/1.8A
6V/.6A
8
5
150K
90V
5K
50W
100K
100K
39K
.001
IMEG
V3,4
6SA7-GT
TP 33
.001
100K
20
5.6K
85V
SW SET FOR OPERATION FROM LIGHT INCREASE
.25
1.8 MEG
.25
1.8 MEG
TP 34
2K
50 W
500Ω
45 V
10 V
IMEG
.5
20
SCANNING HEAD
SELECTOR SWITCH
V19,20
GL930
V17
10 MEG
6J7
.02
V18
.05
10 MEG
GL918
OR
IP37
V19
V20
V21
6SL7-GT
2 MEG
10 MEG
.05
6E5
V2
510K
BASE SPEED
500Ω
IMEG
V3
V4
V5
6SJ7
510K
510K
390K
V7-a
V6-a
510K
6.2V
6V
5.7V
5.4V
5.1V
4.8V
117 V
117 V
SCANNING HEAD LIGHT SOURCE
SELECTOR SWITCH LIGHT SOURCE
5
1.25V
500Ω
50W
IMEG
-15V
SENSITIVITY
2K
50W
-80V
TP 36
-45V
V6,7
6H6
V6-b
V7-b
510K
V17
V18
.2
10 MEG
.05
220Ω
51K
SWITCH SET FOR OPERATION FROM LIGHT DECREASE
TP 16
DC PWR SUPPLY
REGISTER MARK SCANNING HEAD
SELECTOR SWITCH
REGISTER MARK INDICATOR
DC BRIDGE
DISCRIM & MIXER CKT
INVERTER

A 3-megohm load, a 90-volt dc source and a vtvm or an oscilloscope are used for testing. When the web is moved so light passes over the register mark, a signal voltage change of at least 0.5 volt is needed to assure normal operation of the controls.

A second important characteristic is shown in Fig. 6. Two conditions are shown, the variations in the web material as in Fig 6-a and the variations in register marks as in Fig. 6-b. In this example a positive signal is shown from the register mark. There are wide variations in some web materials. Both extremes, maximum and minimum, are shown for the web alone and the register marks. For best operation the register-mark minimum should be at least 20 times greater than maximum web variation.

Maintenance

A check of all tubes, except the neon tubes and the phototubes, is desirable whenever the control is serviced. A standard tube checker will do, although it does not guarantee that the tube will work satisfactorily. Some tube difficulties cannot be detected on a standard checker. Keep a full complement of spare tubes on hand at all times and if any tube is questionable, replace it! The tubes and their corresponding sockets should be marked as the tubes must be replaced in the same sockets after checking to insure proper operation. The phototubes have a long life and should not cause trouble unless they are mechanically damaged.

The lenses in the scanning head, its light source and selector switch must be cleaned regularly to maintain reliable operation. The scanning head and the exterior light-source lens must be replaced with the flat side toward the material. The inner light-source lens must be replaced with the flat side toward the lamp.

The rest of the components need no attention unless mechanically damaged. For this reason the unit should be mounted where it is protected against damage from passing vehicles, etc.

Servicing

When trouble crops up, its approximate location and nature can often be determined by the circumstances under which it began. In cases where this approach fails, observational checks should isolate the trouble to a particular section of the control. When the difficulty is isolated, a routine check of circuits and components will indicate the fault.

When troubleshooting, first make sure that the panel is receiving power. This may be checked readily by observing the indicating-eye tube (for green color) and the scanning head and selector switch lamps (for light). If the lamps are lit but the indicating-eye tube is out, check the small panel fuses. If all of these indications are negative, the incoming power lines, including fuses and switches, should be checked. If the lamp in either light source is out but the panel above is getting power, the lamp is burned out and must be replaced.

If the neon tubes flash but the generator field current does not kick, check the detector diode tubes and replace them if necessary. When the diodes are not defective but there is still no generator field current change, check the components in the stabilizing circuit.

Signals from the selector switch may be checked with either a vtvm or an oscilloscope. A 20,000-ohms-per-volt voltmeter will also give a satisfactory check.

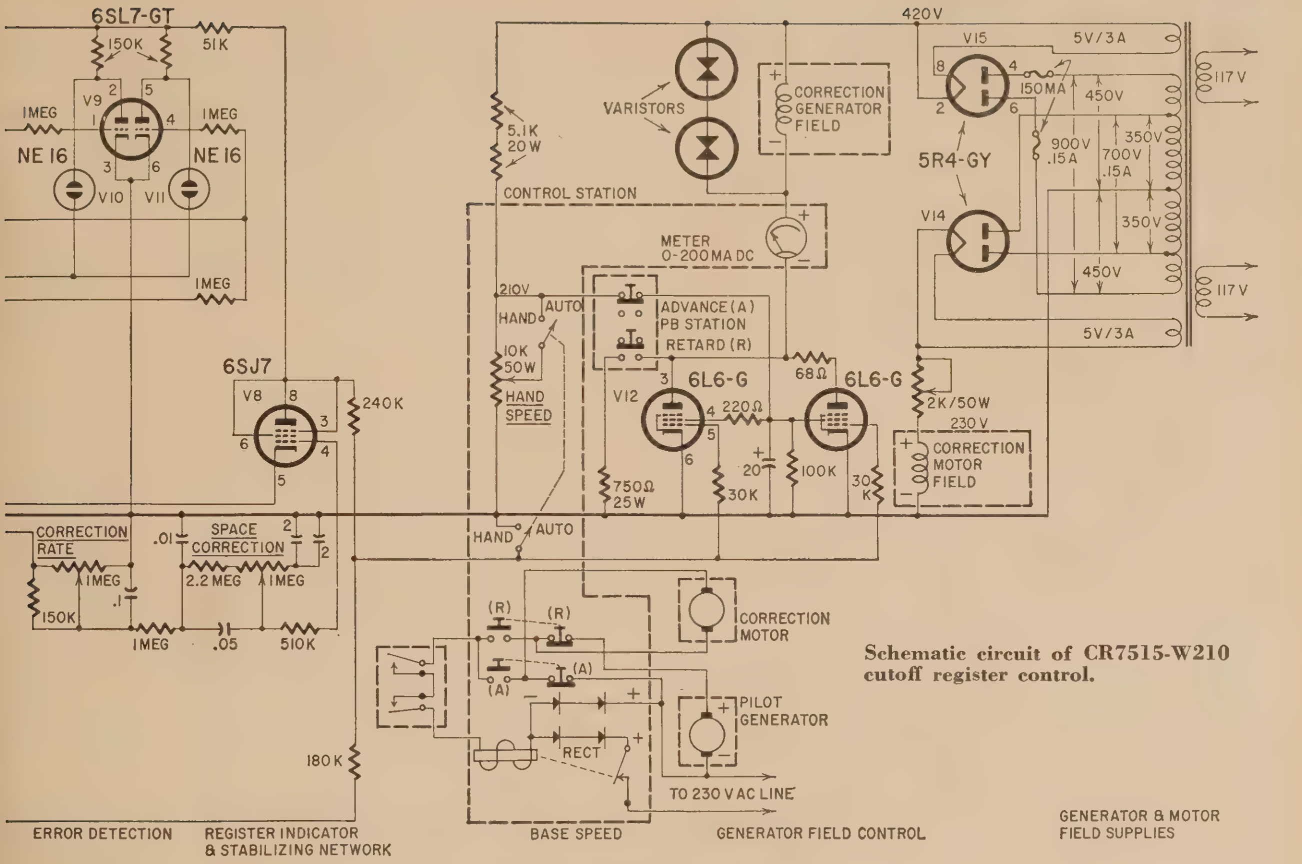
When light falls on phototube V19, a voltmeter connected at TP34 should change from about —30 to +10 volts. This also holds true for V20 and TP33.

It is important that these potentials be as indicated. If this change is not indicated, the amplifier in the selector switch may be bad.

If both tests are positive, place a jumper between the test point and ground and rotate the selector switch by hand. This gives the effect of a continuous register-mark signal. As the disk in the selector switch rotates, first one and then the other neon tube should flash and the generator field-current meter should kick first in one direction and then in the other, but its average value should not change appreciably from its base-speed value.

When the control seems to hold register but does not hold it accurately, check the dead-zone adjustment on the selector switch.

If faulty operation has been traced


6SL7-GT
150K
51K
V9
IMEG
NE 16
V10
V11
6SJ7
V8
240K
180K
CORRECTION RATE
SPACE CORRECTION
.01
2.2 MEG
IMEG
150K
.1
.05
510K
420V
VARISTORS
5.1K 20W
CORRECTION GENERATOR FIELD
CONTROL STATION
METER 0-200MA DC
210V
HAND
AUTO
10K 50W
HAND SPEED
ADVANCE (A) PB STATION
RETARD (R)
V12
6L6-G
6L6-G
68Ω
220Ω
20
100K
30K
750Ω 25W
2K/50W
230V
CORRECTION MOTOR FIELD
CORRECTION MOTOR
PILOT GENERATOR
RECT
TO 230 V AC LINE
V15
5V/3A
150MA
450V
900V .15A
700V .15A
350V
5R4-GY
V14
117V
ERROR DETECTION
REGISTER INDICATOR & STABILIZING NETWORK
BASE SPEED
GENERATOR FIELD CONTROL
GENERATOR & MOTOR FIELD SUPPLIES

Schematic circuit of CR7515-W210 cutoff register control.

to the control, voltages should be checked. A vtvm or a 20,000-ohms-per-volt voltmeter should be used and all measurements made between ground and the point listed, with the common lead being connected to ground. These readings should be made with the machine stopped.

At times it is desirable to run the machine when trouble has been traced to the control. If the machine will not be damaged by being run without material, functions of the control can be observed and checked under these simulated operating conditions.

An oscilloscope simplifies trouble-shooting, since the signals from the scanner and selector switch may be followed through the control and the exact spot where these signals are lost can be located.

With an understanding of how the circuit works the trouble may be located readily with an oscilloscope, if it is electrical and not mechanical. With or without an oscilloscope, however, there is no substitute for a thorough understanding of the circuit when troubleshooting.

General

Signals seen on a scope will vary, depending upon the differences in the web material and the register marks. The characteristics of each web material and the register marks must be determined for proper servicing. Fig 7, for example, shows several signal levels from a representative phototube control. In Fig. 7-a, the signal level is set correctly so that only the desired pulse is above the operating level. In Fig. 7-b, the signal level is too low. The control *might* work, but not reliably. The third drawing, Fig. 7-c, illustrates too high a level because the signal and the peak noise pulses are both above minimum. This causes false triggering and improper operation. Only the condition shown in Fig. 7-a is desirable.

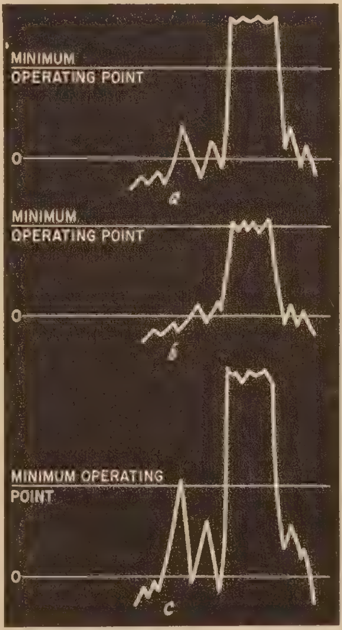


Fig. 7—Effect of signal-level adjustment on register-mark signal: a—correct setting; b—too low; c—too high.

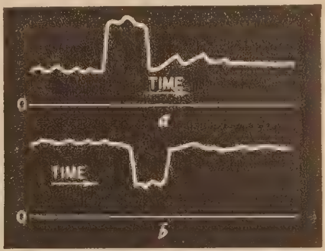


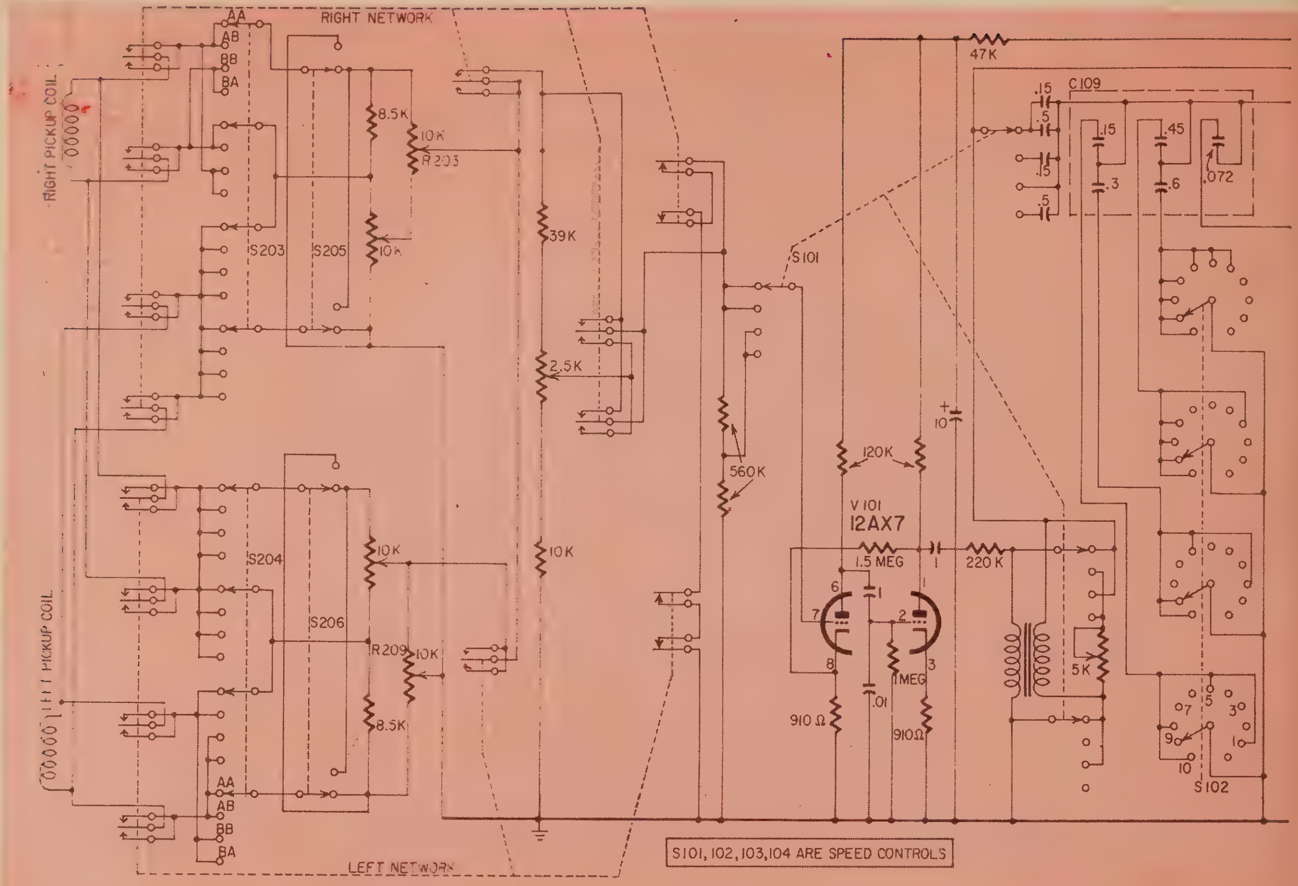
Fig. 8—Pulse formed as register mark passes by (a) increased light falling on phototube; (b) decreased light falling on phototube.

Both negative and positive pulses are possible, depending upon the type of phototube circuit and the number of amplifiers. In Fig. 8 a pulse for light increase is shown in Fig. 8-a and for light decrease in Fig. 8-b.

The following list of servicing checks is suggested as a way to prevent trouble.

1. Check light source for bright, steady light. Lenses must be clean.
2. Check alignment and focus of scanner. Direct interference from other light sources should be kept from the phototube and the register marks.
3. Check signal amplitude and variation.
4. Check line-voltage variations and common grounding.

END


RIGHT NETWORK
AA
AB
BB
BA
RIGHT PICKUP COIL
8.5K
10K
R203
S203
S205
10K
39K
2.5K
47K
.15
C109
.5
.15
.5
.15
.45
.3
.6
.072
S101
560K
+
10
120K
V101
12AX7
1.5 MEG
1
220K
6
7
8
1
2
3
.01
1MEG
910Ω
910Ω
5K
7
5
3
9
1
10
S102
S204
S206
R209
10K
10K
8.5K
10K
LEFT PICKUP COIL
AA
AB
BB
BA
LEFT NETWORK
S101, 102, 103, 104 ARE SPEED CONTROLS

ELECTRONIC BALANCING for BETTER MOTORS

Balance the rotor of a fractional-horsepower motor and you increase efficiency, and reduce wear and vibration. One way to do this is with an electronic dynamic balancer

By J. W. ESSEX*

SMALL electric motors are in constant use wherever you turn—phonographs, drills, saws, typewriters and mixers. The heart of these fractional horsepower motors is the rotor, which turns at speeds as high as 3,400 rpm. If the rotor is balanced, there are no problems; if it isn't, the motor will be noisy and vibrate. It will also wear excessively and be inefficient. Such vibration can even make a motor shake itself to pieces—holding nuts work loose, tie rods fall out and the whole works comes apart.

How are rotors balanced? The old method called for taking the completed rotor and placing it on a set of two steel rails. If unbalanced it would roll along the track until the heavier weight of one side would bring it to rest. Then the operator would remove the rotor and place it in a drill press. After drilling out some of the mass from the heavy side, the rotor would go back to the rails for another check, and so on until it was balanced properly.

The process works well, but is too slow. Using this method, two men could run off only 150 rotors a day, far short of a desired target of 700 a day. Also, static balancing does not reveal dynamic unbalance caused by two equal weights at equal distance from the rotational axis and located on opposite ends of the rotating part (Fig. 1).

Electronic balancing

The solution to the problem came in the form of an electronic balancing machine. It has proved itself by turning out more, better-balanced rotors per day. The result is

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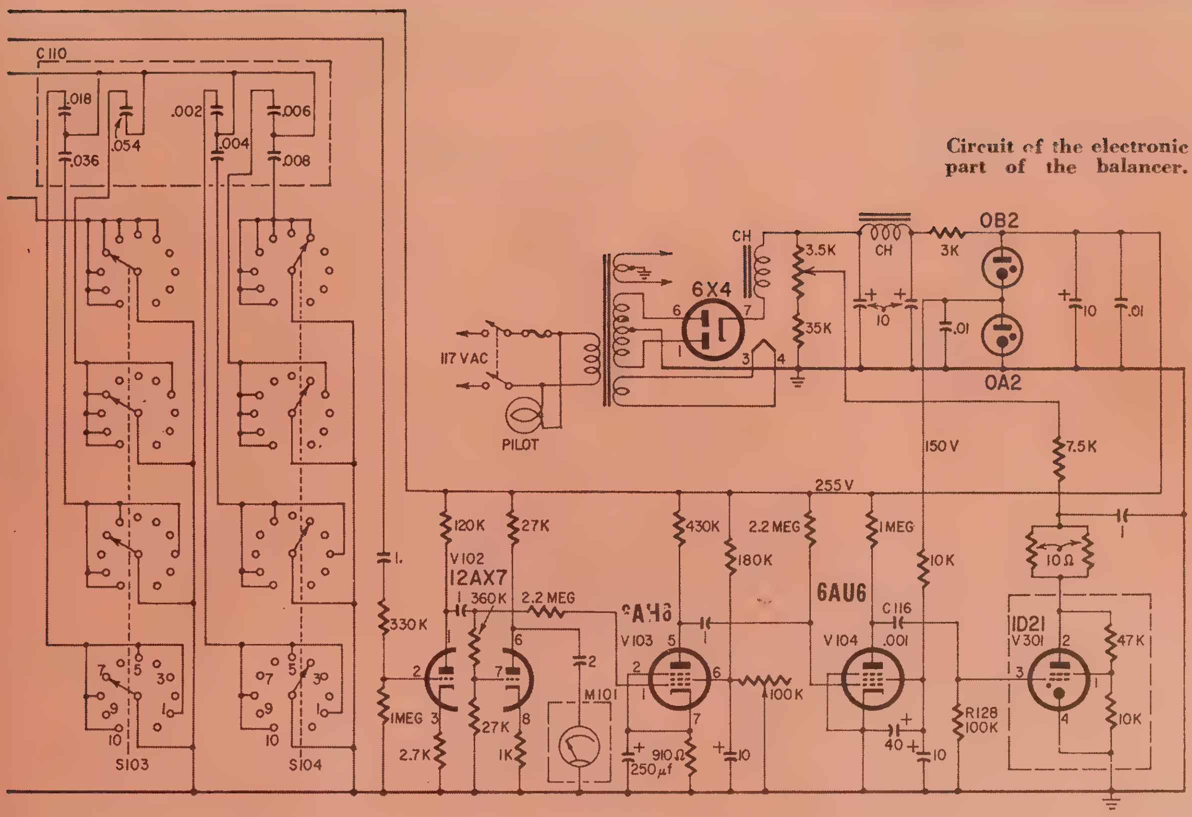
*Former inspector, quality control, Small Motor Div., Canadian Westinghouse, Hamilton, Canada.



Circuit of the electronic part of the balancer.

higher quality at lower cost, a survival prerequisite in this mechanical age.

The time-consuming part of rotor balancing is in finding the unbalance point and the amount of mass that must be removed to balance the rotor. Here's how this problem is handled by the Gisholt Dynetric balancer, a machine with which the author is familiar.

The rotor to be balanced is placed on the Dynetric balancer as shown in Fig. 2. A numbered reference ring is attached around the rotor and a belt drive placed around the center of the rotor. When the balancer is turned on, the rotor is spun at about 800 rpm. If it is unbalanced, it will vibrate in its cradle, move a couple of coils in a magnetic field, producing a sine-wave output. The output is amplified and shaped to produce pulses that fire a strobe light. The vibrations appear at the same time during each revolution, so the light flashes at the same time each revolution. The operator notes the reference number that appears in the strobe light over the reference pointer. This identifies the off-balance point. The meter tells the operator how much weight must be taken off or added. (The more common practice is to drill out the necessary material.) After this is done, another check is made and if the rotor passes, the job is done.

Balance a rotor

Now let's take a closer look at the electronics side of the operation. How is the vibration picked up and changed to a pulse that triggers the strobe light?

A rotor to be balanced is placed in a cradle (Fig. 3) that consists of two supports attached to coils which move in strong magnetic fields. The more the coils move in the magnetic fields the greater their voltage output. The coils' outputs are fed to a common meter which indicates a voltage when either end of the rotor moves up and down.

When the rotor is unbalanced, represented by weight W on the right side, and is rotated, it vibrates between lines Y–Y and Z–Z. As the right side swings more than the left side, the voltage induced in coil A is greater than that in coil B. The coils are arranged so the voltages fed to the meter buck each other and the meter reads only the difference.

By adjusting coil A's output with the potentiometer, the meter can be zeroed. In this way the effect of weight W in the right plane is balanced out. If a weight is placed on the left end of the rotor, the meter would measure the unbalance in the left plane. This is how the two planes of the rotor are separated for balancing.

In use, the pickup coils are followed by somewhat complicated networks and level or volume controls. They can be seen in the main diagram at the head of this article, the complete electronic circuit of the Gisholt balancer.

Of course, the weak vibrations set up by the rotor must be amplified before they can be used, and this is where electronics comes in. The amplifier uses four tubes (in addition to the strobotron, rectifier and voltage regulators) to provide amplification in the order of 1,600,000 times. The output from the coils is fed to a 12AX7 (V101) for impedance matching and early amplification. The signal then goes to V102, another 12AX7 used as a resistance-coupled amplifier to drive meter M101, which indicates the amount of unbalance. The filter network between V101 and V102 cuts down extraneous vibrations which could cause false readings. They are tuned filters that eliminate all vibrations except at the frequency at which the rotor is turning (usually 800 cycles). To trigger the 1D21 strobotron two additional amplifiers are used. (The signal amplitude that triggers the strobe light is 15 times greater than that fed to the meter.) These pentodes (6AH6 and 6AU6) square the pickup voltage before they are differentiated by C116 and R128 and fed to the strobe tube.

The gas-filled strobe tube flashes each time a pulse reaches its grid. The flashing light makes the rotor appear to stand still, and the numbered reference ring identifies the spot. The same lamp, reference pointer and numbered ring are used in locating the point of correction in each of the two correction planes.

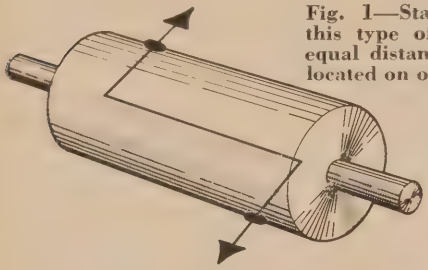
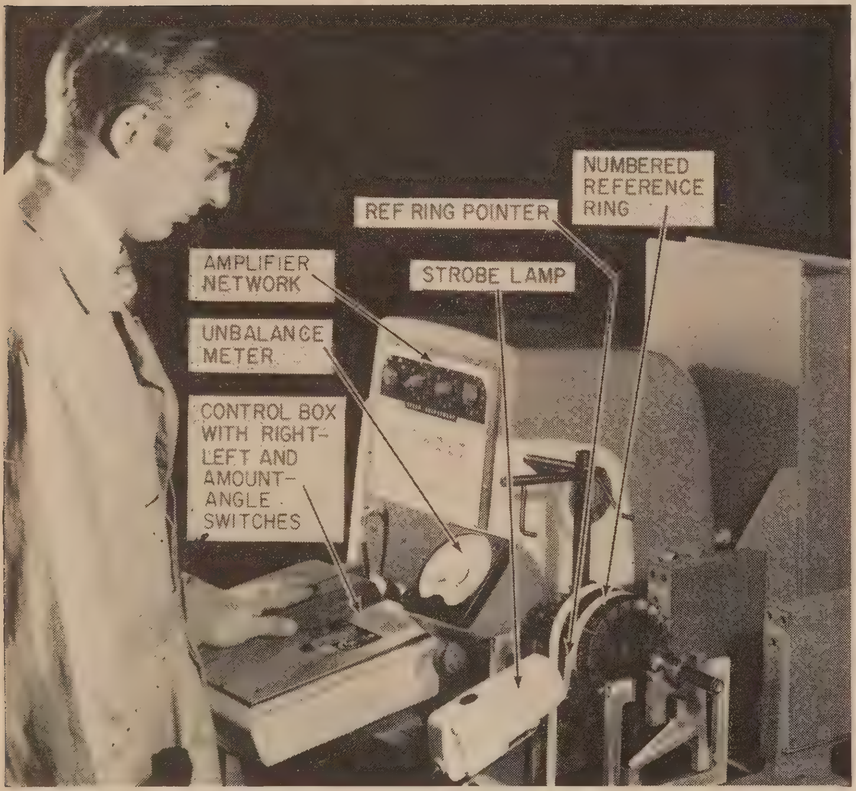


Fig. 1—Static balancing will not disclose this type of misbalance—equal weights at equal distance from the rotational axis and located on opposite ends of the rotating part.

Fig. 2—Gisholt Dynetric balancer in operation.



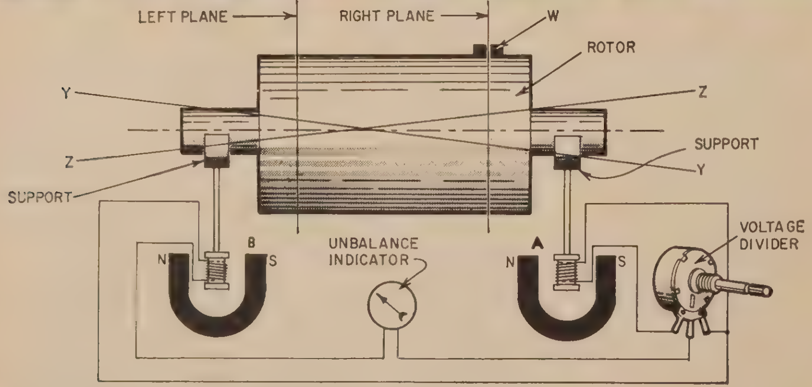


Fig. 3—How rotor vibration is transformed into an electronic signal.

At these points a small amount of mass is drilled out. The necessary amount is shown on a chart that lists the size of the drill bit and depth to use.

Set up the balancer

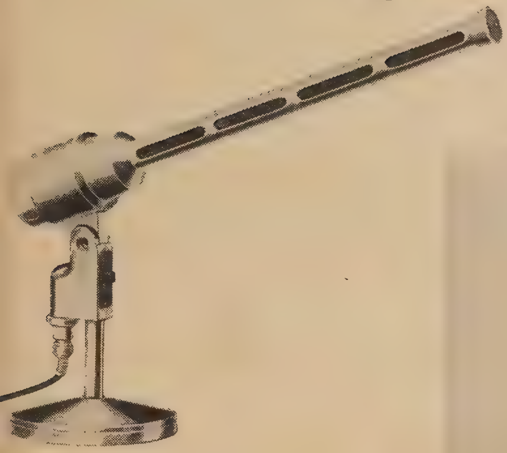
The balancer is only as good as the man setting it up. The trick is to get a good minimum in each plane, using a test rotor and adding modeling clay to each side in turn. This gives a zero standard to set the machine for. It also insures that any unbalance in the right plane will not affect unbalance in the left plane and vice versa.

Let's run through a sample setup to show how this is done. First we want to balance out any unbalance in the right plane in relation to the left plane. To do this we place a rotor in the cradle and add weight in the form of modeling clay in the right plane. The control box left/right switches are set for the left plane. The rotor is set spinning and a reading is taken from the meter, which is set for coarse measurements. Once it is taken, a small amount of clay is added and the rotor is spun once again. If this causes an increase in the meter reading, reverse the input switch before continuing. As the operator proceeds, adjusting controls as he goes along, the meter reading drops each time clay is added. As the readings get low, the operator switches to the fine reading and continues adding clay and rechecking. When readings get low once again, the operator keeps adding clay and checks the settings of switches S204 and S206 and potentiometer R209 (only one combination of these controls will give a zero reading). This continues until a zero reading is obtained. Now that the left side is balanced the operator sets the left/right switch to right and repeats the process, this time adding clay to the left side of the rotor. When doing final balancing on this side, switches S203, S205 and potentiometer R203 are adjusted.

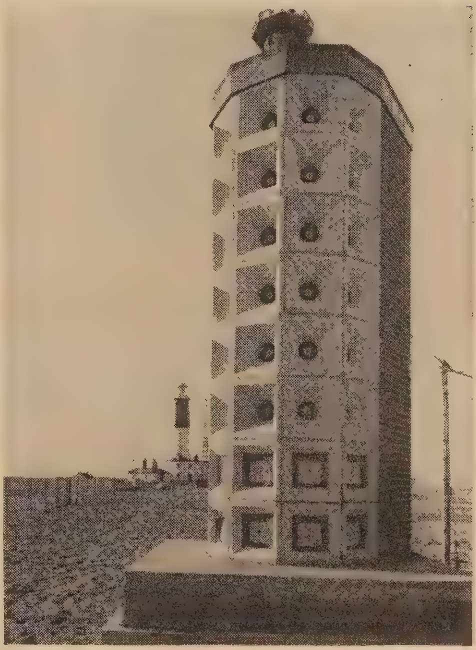
Once established, settings are recorded so that for successive rotors of the same type approximate settings can be made without all the preliminaries given here. In our plant we eventually got a list of figures for all the rotors we make. It simplifies the job considerably when switching from one rotor to another.

Now the angle/amount switch is set to angle and the strobe light flashes, indicating the point of the unbalance. In this way electronics gives us a machine that makes low-cost, high-quality fractional-horsepower motors possible. END

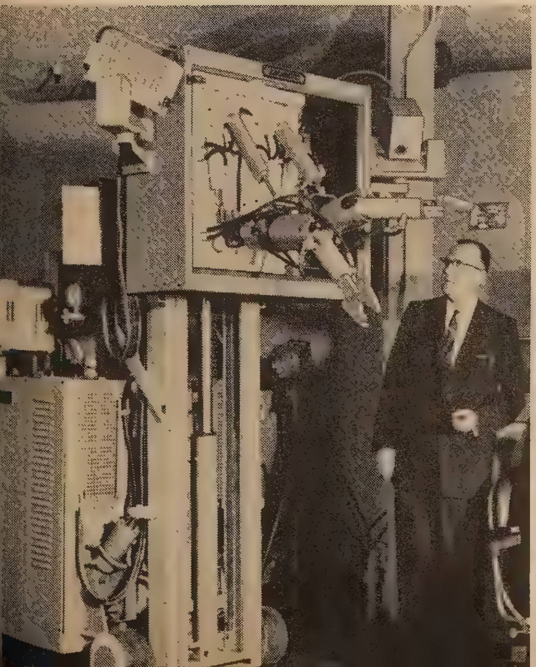
what's new?



MICROPHONE maintains proper response three times normal distance from the sound source, cancels noise from rear and sides. Known as the Electro-Voice 644 Sound Spot, it uses a cardioid unit and the interesting distributed front opening shown to accept sound 45° each side of center, reduce sound from unwanted directions more than 20 db. Response: 40–12,000 cycles.



LOUDSPEAKING LIGHTHOUSE at Dungeness, Kent, England, will have 60 big cone speakers, beaming 3 kw of audio out to sea, in place of the old-fashioned foghorn. The stack of speakers, set up for testing in the photo, will be mounted in the upper portion of the lighthouse. An automatic photocell fog detector will turn the horn on when needed. (More information on the lighthouse was printed in RADIO-ELECTRONICS, December, 1959, on page 16.)



MOBOT MARK I, mobile replacement for man in dangerous areas, is completely remote-controlled. Lifts, moves, places, takes apart units up to 1,500 lb. Hears all, sees all, uses wrenches, screwdrivers, hammers, shears. Operating range limited to 200 feet by length of control cable. Hughes Aircraft developed Mobot for AEC contractor Sandia Corp.

TALLEST STRUCTURE ever erected by man is the tower of station WGAN-TV, Portland, Me. A third of a mile high (1,619 feet), almost twice the height of the Eiffel Tower, 154 feet more than Empire State Building, the tower sways up to 6 feet in high winds, can stand 150-mile-per-hour gales. Built by Kline Iron & Steel, Columbia, S. C.

SERVICING CHROMA DEMODULATORS

Do the people on the color TV screen have blue faces? If they do, this article may help you locate the trouble

By ROBERT G. MIDDLETON
RADIO-ELECTRONICS TELEVISION CONSULTANT

COLOR pictures are incorrectly reproduced when something goes wrong in the chroma demodulator (chroma detector) circuits. Several types of chroma demodulator circuits are used in modern color TV receivers. These are: (R − Y) (B − Y) circuits; (R − Y) (G − Y) circuits; bootstrap circuit; XZ circuit.

Formerly, the IQ demodulator circuit was extensively used. An (R − Y) Q circuit was used prior to the XZ circuit.

Some types of servicing procedures are the same for all chroma demodulator systems. Other servicing methods differ for each type of circuit.

We will consider these in order. The basic plan of the (R − Y) (B − Y) system is shown in Fig. 1. Some receivers use diode demodulators, as in Fig. 2. Let us review the servicing procedures for this configuration.

A preliminary test for demodulator trouble can be made with a vtvm, as

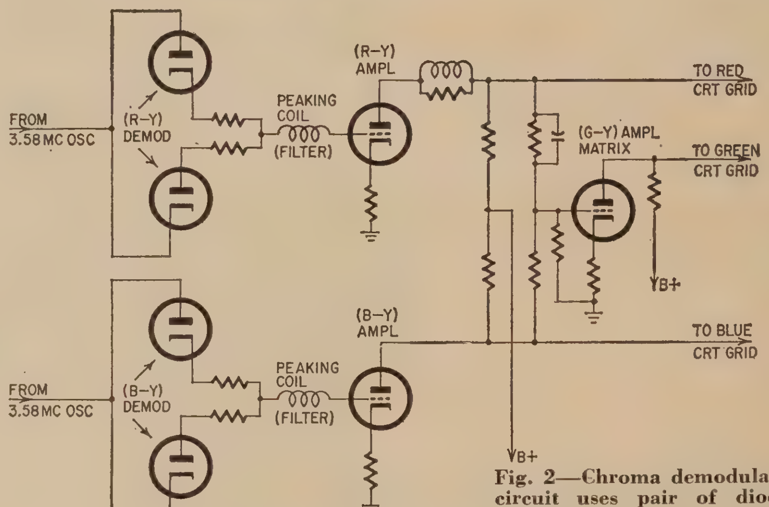
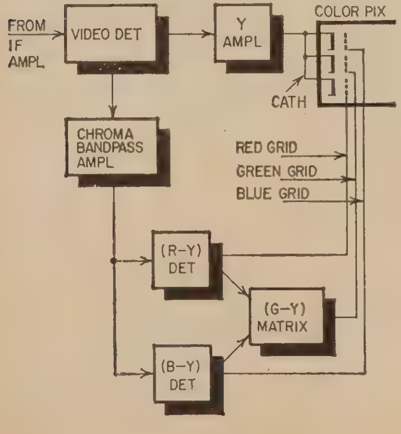

FROM 3.58 MC OSC
(R−Y) DEMOD
PEAKING COIL (FILTER)
(R−Y) AMPL
TO RED CRT GRID
(G−Y) AMPL MATRIX
TO GREEN CRT GRID
B+
FROM 3.58 MC OSC
(B−Y) DEMOD
PEAKING COIL (FILTER)
(B−Y) AMPL
TO BLUE CRT GRID
B+

Fig. 2—Chroma demodulator circuit uses pair of diodes in one type of receiver.

Fig. 1—Basic plan of the (R − Y) (B − Y) chroma demodulator system.


FROM IF AMPL
VIDEO DET
Y AMPL
COLOR PIX
CATH
CHROMA BANDPASS AMPL
RED GRID
GREEN GRID
BLUE GRID
(R−Y) DET
(G−Y) MATRIX
(B−Y) DET

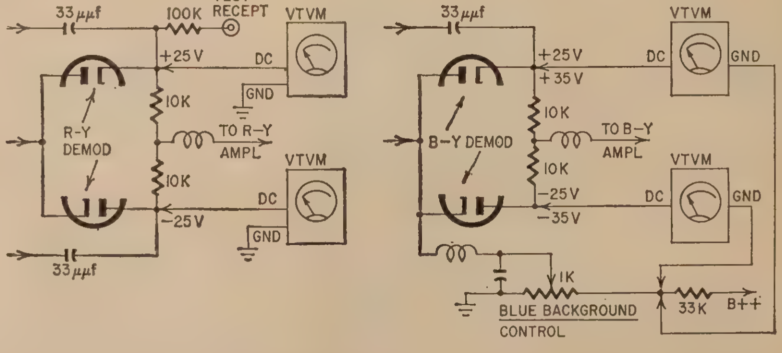

33μμf
100K
TEST RECEPT
VTVM
+25V
DC
GND
10K
R−Y DEMOD
TO R−Y AMPL
10K
VTVM
DC
−25V
GND
33μμf
33μμf
VTVM
+25V
+35V
DC
GND
10K
B−Y DEMOD
TO B−Y AMPL
10K
VTVM
−25V
−35V
DC
GND
1K
BLUE BACKGROUND CONTROL
33K
B++

Fig. 3—Vtvm tests of diode-type (R − Y) (B − Y) chroma demodulators.

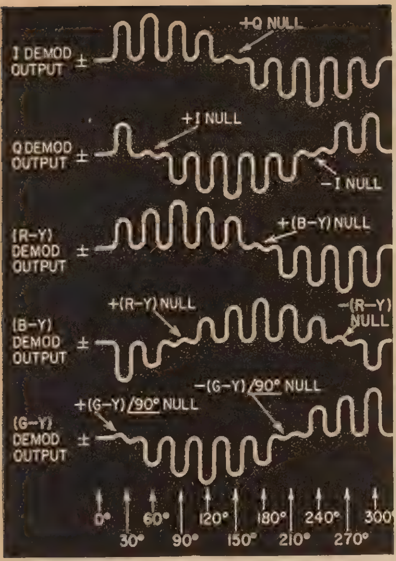


Fig. 4—Correct null points for chroma demodulators, using a keyed rainbow test signal.

in Fig. 3. No signal input is applied to the receiver. Equal values of dc voltages must be found at the test points indicated. Note the 1,000-ohm pot in the B − Y demodulator circuit. This is a blue-background control. The exact voltage measured at a B − Y demodulator test point will vary, depending on this control's setting. Nevertheless, equal values are found at the two B − Y test points if the circuit is operating properly. Note that a positive voltage appears at one tube, and a negative voltage at the other.

The voltage measured with the vtvm comes from the subcarrier oscillator. If it is weak, look for trouble in the subcarrier oscillator circuit. If it is unbalanced, look for faulty resistors in the demodulator circuit.

Chroma demodulators normally measure from 25 to 35 dc volts in this type of test. In this circuit, it is important to have adequate subcarrier voltage.

Another useful test can be made with a keyed rainbow signal. If such a signal is applied to the receiver and a scope is connected at a chroma demodulator output, patterns like those shown in Fig. 4 are seen. The output must go to zero (null) on certain "pips." Fig. 4 shows the required nulls for I, Q, R − Y, B − Y, and G − Y demodulators.

If you don't get the required null, try adjusting the color phasing control. If it is out of range, adjust the master color phasing control. This is a capacitor or a slug-tuned coil in the burst amplifier section, and can be located from the receiver's service data.

Having obtained a correct null from the R − Y demodulator, check the B − Y demodulator next. If the B − Y null is incorrect, try adjusting the quadrature transformer. The quadrature transformer is located between the subcarrier oscillator and the chroma demodulators.

It is usually possible to get correct nulls on both the R − Y and B − Y demodulators by adjusting the quadrature transformer. However, if you cannot get correct nulls from both demodulators, there is a fault in the demodulator circuits, or the quadrature transformer is defective.

The easiest way to adjust the quadrature transformer is to connect the output from the R − Y demodulator to the scope's vertical input terminals, and output from the B − Y demodulator to the scope's horizontal input terminals. A circular pattern on the scope screen, as illustrated in Fig. 5, indicates correct adjustment.

You will note a wedge-shaped sector in the circular pattern. This is caused by the burst blanking action. The wedge revolves around the circle as you adjust the color phasing control.

The wedge also revolves when you adjust the slugs in the quadrature transformer. The normal position for the wedge depends on the type of demodulator system. The correct position for the (R − Y)(B − Y) system is shown in Fig. 6.

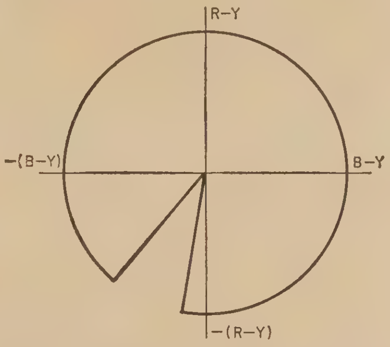


Fig. 5 — When the quadrature transformer is properly adjusted we can get a circular pattern on the scope screen. Otherwise we can only get a tilted ellipse.

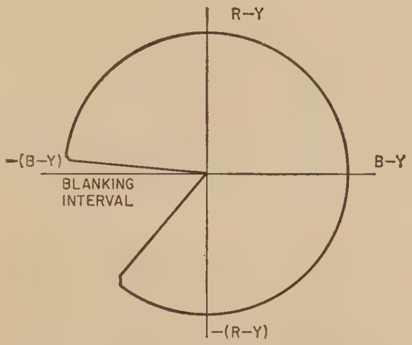


Fig. 6 — Normal wedge position for (R − Y) (B − Y) chroma demodulators.

We set the color phasing control to the mid-point of its range, and then adjust the quadrature transformer to make the wedge appear as in Fig. 6. Otherwise, the control will be off range when we check for the nulls in Fig. 4.

Perhaps you prefer to use the NTSC type of generator in making demodulator tests. These generators have individual R − Y and B − Y test signals. They appear on a wide-band scope screen as in Fig. 7. The R − Y bar is narrower than the B − Y bar. This provides bar identification in the signal-tracing tests described later.

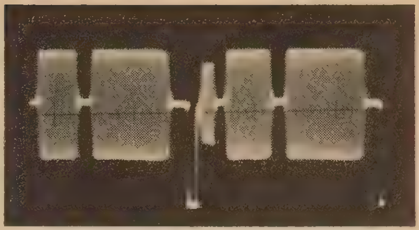


Fig. 7—A display of an R − Y bar and a B − Y bar from a color bar generator as seen on the screen of a wide-band scope. The difference between the two signals cannot be seen in this type of pattern, since they differ in phase only.

When this type of test signal is used, proper operation of the R − Y and B − Y demodulators gives patterns like those in Fig. 8. A scope connected at the R − Y demodulator output shows a square wave on the R − Y signal, but a null on the B − Y signal. Likewise, at the B − Y demodulator output, a square wave is obtained on the B − Y signal, but a null on the R − Y signal.

If we use a 100% saturated NTSC color bar test signal, we observe crankshaft patterns at the chroma demodulator outputs. Patterns for correct operation of the R − Y and B − Y demodulators, as well as the Y channel, are shown in Fig. 9.

Pentode chroma demodulators

Quite a few (R − Y)(B − Y) chroma demodulators use pentode tubes, instead of duo-diodes. A typical pentode demodulator is shown in Fig. 10. The chroma signal is applied to the control grid. The subcarrier oscillator signal is applied to the suppressor grid. Demodulated output is taken from the plate circuit.

The tests described previously for duo-diode chroma demodulators are used in the pentode configuration too, with the exception of the vtvm test. The

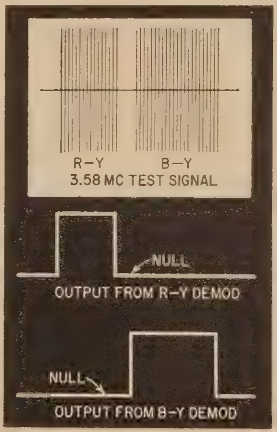


Fig. 8—R − Y and B − Y test signal and scope patterns found at the chroma demodulator outputs.

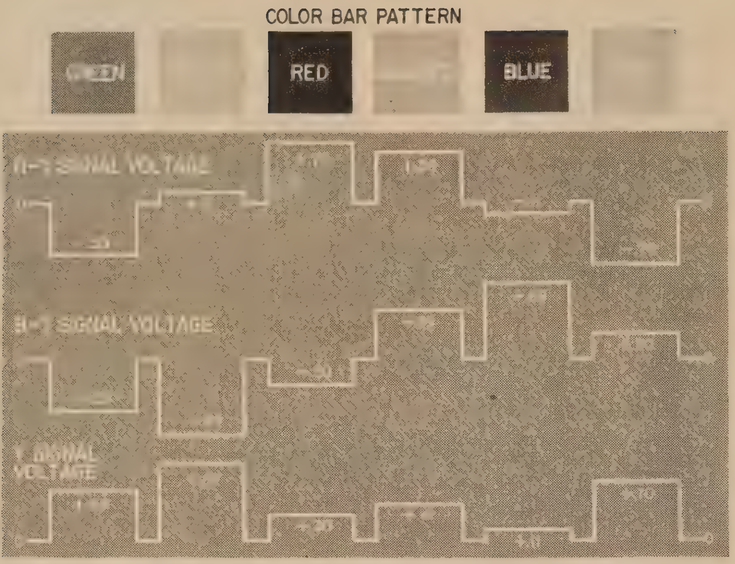

COLOR BAR PATTERN
GREEN
RED
BLUE
R-Y SIGNAL VOLTAGE
B-Y SIGNAL VOLTAGE
Y SIGNAL VOLTAGE

Fig. 9—Correct crankshaft scope patterns for normal operation of the R − Y and B − Y demodulators. Y crankshaft pattern is also shown.

pentode provides amplification. Its gain is about 10. A gain test is made with a scope and low-capacitance probe.

When an R − Y test signal is applied to the grid, a scope test should show 10 times more deflection at the plate than at the grid. If not, look for circuit faults. Also check the subcarrier voltage at the suppressor grid. There should be at least 20 volts peak to peak, in normal operation.

Peaking coils are used in the plate circuit, as in Fig. 10. Sometimes one of the coils has an adjustable slug. In other receivers, fixed peaking coils are used. The coils must have correct inductance values. Otherwise, the demodulator's bandpass is incorrect and color reproduction suffers.

The best way to test the peaking coils is to use a sweep generator and scope. Apply a video sweep signal to the grid of the demodulator tube, as in Fig. 11. Use a demodulator probe at a low-impedance point in the output circuit—the cathode of a phase splitter is suitable, as in Fig. 11. Do not apply the probe at a high-impedance point, or the curve will be distorted. If the probe is connected at X in Fig. 11, you run into distortion. However, the probe can be properly applied at Y. A typical curve is shown in Fig. 12. It has absorption markers at 0.5 and 1.5 mc. However, be sure to consult the service data for the particular chassis you are working on.

If the response curve is incorrect, look for defective or incorrectly tuned peaking coils. Off-value load resistors also cause curve distortion.

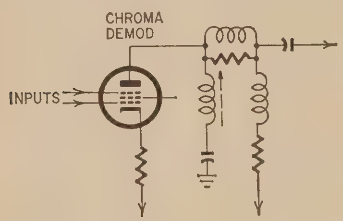

CHROMA
DEMOD
INPUTS

Fig. 10—A pentode chroma demodulator.

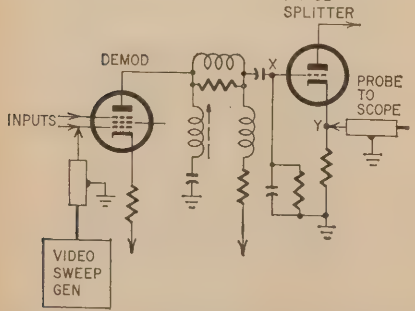

PHASE
SPLITTER
DEMOD
X
INPUTS
PROBE
TO
SCOPE
Y
VIDEO
SWEEP
GEN

Fig. 11—Checking frequency response of a chroma demodulator.

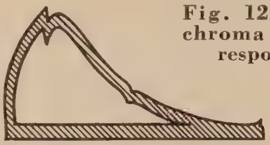


Fig. 12—A typical chroma demodulator response curve.

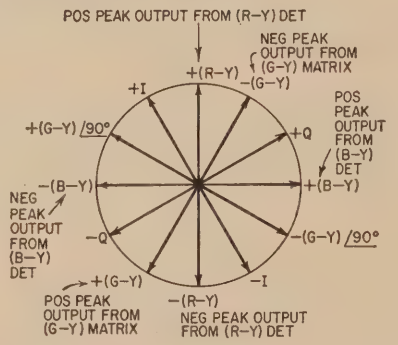

POS PEAK OUTPUT FROM (R−Y) DET
NEG PEAK OUTPUT FROM (G−Y) MATRIX
+(R−Y)
−(G−Y)
+I
+(G−Y) /90°
+Q
POS PEAK OUTPUT FROM (B−Y) DET
−(B−Y)
+(B−Y)
NEG PEAK OUTPUT FROM (B−Y) DET
−Q
−(G−Y) /90°
+(G−Y)
−I
POS PEAK OUTPUT FROM (G−Y) MATRIX
−(R−Y)
NEG PEAK OUTPUT FROM (R−Y) DET

Fig. 13—G − Y is not in quadrature to either R − Y or B − Y. It is in quadrature only to (G − Y)/90°.

(R – Y)(G – Y) demodulators

Quite a few modern color receivers interchange the positions of the B − Y demodulators and the G − Y matrix. That is, G − Y is developed in a chroma demodulator. B − Y is then obtained by matrixing G − Y with R − Y. This method gives a somewhat better signal-to-noise ratio.

This is not a quadrature demodulation system, as seen from Fig. 13. R − Y and G − Y are not separated 90°, as are R − Y and B − Y. Chroma demodulators can be operated along any pair of axes.

Servicing (R − Y)(G − Y) demodu-

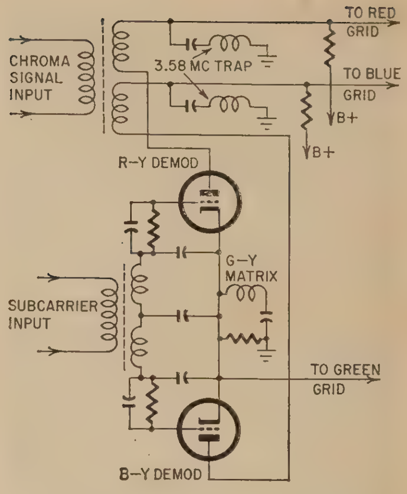

TO RED
GRID
CHROMA
SIGNAL
INPUT
3.58 MC TRAP
TO BLUE
GRID
B+
B+
R−Y DEMOD
G−Y
MATRIX
SUBCARRIER
INPUT
TO GREEN
GRID
B−Y DEMOD

Fig. 14 — The bootstrap demodulator matrixes G − Y in its common cathode circuit.

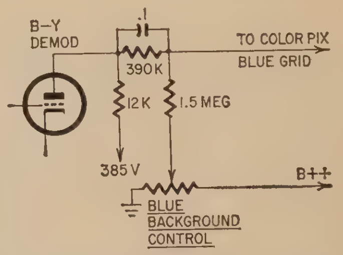

.1
B−Y
DEMOD
TO COLOR PIX
BLUE GRID
390 K
12 K
1.5 MEG
385 V
B++
BLUE
BACKGROUND
CONTROL

Fig. 15—Blue background control varies the dc bias on the blue grid.

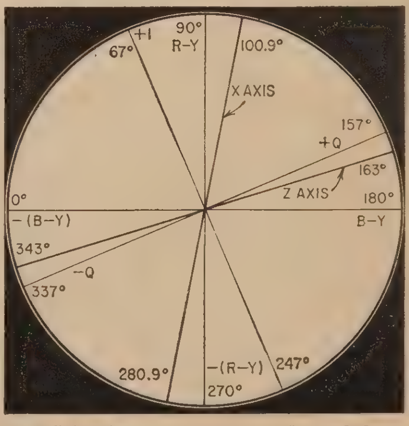

90°
R−Y
+I
67°
100.9°
X AXIS
157°
+Q
163°
Z AXIS
0°
180°
−(B−Y)
B−Y
343°
−Q
337°
280.9°
−(R−Y)
270°
247°

Fig. 16—An XZ chroma demodulator operates on subcarrier phases which are in the vicinity of the R − Y and Q axes.

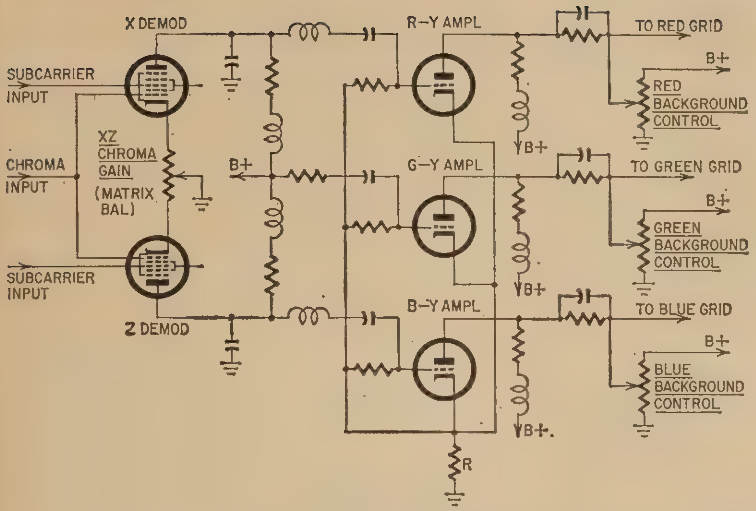


Fig. 17—The three color-difference amplifiers have common-cathode circuit. X and Z signals are thereby converted into R−Y, B−Y and G−Y.

lator circuits is very similar to servicing (R − Y) (B − Y) circuits; the same principles apply throughout. A G − Y demodulator must have sufficient 3.58-mc subcarrier oscillator voltage, just as the R − Y and B − Y demodulators discussed earlier. It nulls on the quadrature (G − Y) /90° signal, if operating properly. Frequency response can be checked with a sweep generator, demodulator probe and scope.

Bootstrap demodulators

The chroma demodulators we discussed are low-level circuits. They are followed by amplifiers, before their signal is applied to the color picture tube.

On the other hand, the bootstrap demodulator illustrated in Fig. 14 is a high-level circuit. The outputs are applied directly to the picture-tube grids. It is an economy design, widely used in present-day color receivers.

Faults in a bootstrap demodulator are often more difficult to spot by picture analysis than in other demodulator configurations. This is because the bootstrap circuit branches interact. However, the test principles discussed earlier still apply. That is, if we apply an R − Y test signal to the receiver, the B − Y channel normally nulls. The R − Y channel normally nulls on a B − Y signal. The G − Y channel normally nulls on a (G − Y) /90° signal.

Note that the output from the bootstrap demodulator is dc-coupled to the picture-tube grids. Dc coupling is also used in the Fig. 2 configuration.

Nearly all modern color receivers have dc-coupled chroma channels. This eliminates the need for dc restorer circuits. Dc coupling results in raster tinting when circuit trouble occurs. Note that the plate voltages for the triodes in Fig. 14 are also bias voltages for the picture-tube grids. For this reason, trouble in such circuits causes a red, green or blue raster, even in black-and-white reception.

Grid bias is varied with a background control, often connected as in Fig. 15. It controls grid bias through the required range. The grid bias is obtained from both the background control and the demodulator plate.

The XZ demodulator circuit

Some present-day color receivers use the XZ system of chroma demodulation, shown in Fig. 16. The XZ configuration is comparable to the (R − Y) (G − Y) arrangement, in that it is not a quadrature demodulation system. The axes of demodulation are in the region of the R − Y and Q axes. (See Fig. 16.)

R − Y, B − Y and G − Y outputs are obtained from the amplifier tubes shown in Fig. 17. These are also matrixes. Note that resistor R is common to the three cathodes of the color-difference amplifiers. The R − Y and B − Y amplifiers are grid-driven. The G − Y amplifier is cathode-driven.

A chroma gain control is provided in the X and Z demodulator-tube cathode circuits. It is adjusted to obtain standard nulls from the R − Y, B − Y and G − Y channels.

Hence, servicing the XZ demodulator system is basically similar to the procedures described for other chroma demodulator circuits. If correct nulls are not obtained on the three quadrature test signals, we check the phasing transformer between the color-subcarrier oscillator and the XZ demodulators, check the setting of the XZ gain control and the subcarrier injection voltage to the demodulators (this should be about 20 volts peak to peak).

If these checks do not give correct nulls, dc voltage checks in the demodulator circuits come next, and the voltages measured are compared with those specified in the receiver's service data. A scope and low-capacitance probe help localize ac signal distortion and incorrect peak-to-peak voltages. These checks assist in localizing a faulty component in a demodulator circuit. END

NEXT MONTH

How Good Are Speaker Response Curves?

Design engineers and high-fidelity listeners alike know that the response curves of a speaker or speaker system cannot be depended on to give an idea of its performance in a given living room. This story tells some of the reasons.

Audio Aid for the Industrial Technician

A one-transistor oscillator for use on location on industrial jobs, for adjusting motion picture sound equipment and as a signal source for ordinary signal tracing.

Licking the Intermittents

How to conquer the worst of all the technician's troubles—the defect that disappears as you approach the set. All the old methods—and a few you may not have heard of.

Solar Cells

One of the men who were instrumental in developing the original Bell solar cells tells how the experimenter or student can roll his own.

New Transistor Clock Radio Kit

EVERYTHING A CLOCK-RADIO CAN OFFER . . . AND PORTABLE TOO!

- Completely portable, all-transistor circuit
- Runs up to 500 hours on standard batteries
- Deluxe features at half the cost
- Easy to assemble

HEATHKIT TCR-1
$45^{95}

"YOUR CUE" TRANSISTOR CLOCK RADIO KIT (TCR-1)

Take all the deluxe features found in the most expensive clock-radios, add the convenience of complete portability, plus a modern 6-transistor battery operated circuit . . . then slash the price at least in half, and you have the new Heathkit "Your Cue" Transistor Portable Clock Radio.

Packing every modern clock-radio feature into a compact, beautifully styled turquoise and ivory plastic cabinet, "Your Cue" lulls you to sleep, wakes you up, gives you the correct time and provides top quality radio entertainment in and out-of-doors. It can also be used with the Heathkit Transistor Intercom system, opposite page, to provide music or a "selective alarm" system for one or more rooms covered by the intercom system.

An "Alarm-set" hand, hour hand, minute hand and sweep second hand grace the easy-to-read clock dial. All controls are conveniently located and simple to operate. The "lull-to-sleep" control sets the radio for up to an hour's playing time, automatically shutting off the receiver when you are deep in slumber. Other controls set "Your Cue" to wake you to soft music, or conventional "buzzer" alarm. A special earphone jack is provided for private listening or connection to your intercom or music system. At all times crystal-clear portable radio entertainment is yours at the flick of a switch.

The modern 6-transistor circuit features prealigned IF's for ease of assembly. A tuned RF stage and double tuned input to the IF stage assure top performance. The built-in rod-type antenna pulls in far-off stations with outstanding clarity while a large 4″ x 6″ speaker provides tonal reproduction of unusual quality.

Six easily obtainable penlight-size mercury batteries power the radio receiver up to 500 hours, while the clock operates up to 5 months from a single battery of the same type. Ordinary penlight cells may also be used with reduced battery life.

The handsome two-tone cabinet, measuring only 3½″ H. x 8″ W. x 7½″ D. fits neatly into the optional carrying case for beach use, boating, sporting events, hunting, hiking, or camping.

Wherever you are, you'll find "Your Cue" your constant companion. Shpg. Wt. 5 lbs.

LEATHER CARRYING CASE
HEATHKIT
NO. 93-3
$4^{95}
Shpg. Wt. 2 lbs.

HEATH COMPANY/Benton Harbor, Mich.

a subsidiary of Daystrom, Inc.

New Transistor Intercom Kit

TALK WITH ANY OR ALL FIVE STATIONS WITH YOUR OWN INTERCOM SYSTEM

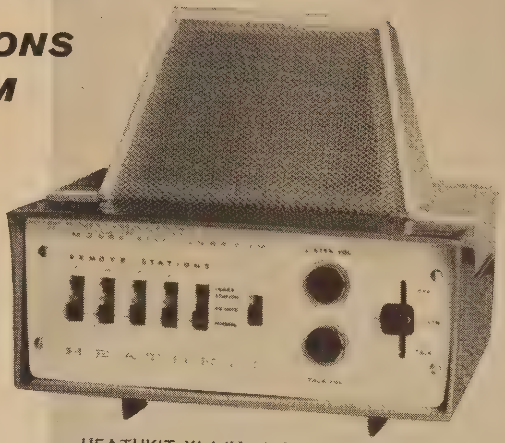
- Battery Power Permits Placement Anywhere
- Versatile Unit has Many Important Uses
- Complete Privacy of Conversations Assured

TRANSISTOR INTERCOM KIT (XI-1 and XIR-1)

A flexible, versatile transistor intercom, has been developed by Heath engineers to enable you to set up your own communications system at an unbelievably low price.

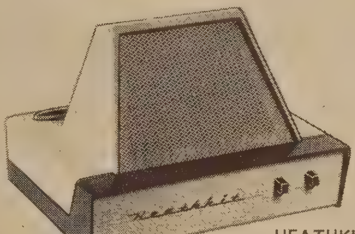
Consisting of a master unit (XI-1) and up to five remote stations (XIR-1), the system is designed for any remote unit to call the master, for any remote station to call any other remote station, or for the master unit to call any single remote unit or any combination of remote units. Complete privacy is assured, since a call to a remote station cannot be interrupted or listened to while the remote unit is in operation unless switched in by the master unit. Used with clock-radio, opposite page, it can serve as a music or "selective alarm" system.

Transistor circuitry means long life, instant operation and minimum battery drain. Eight ordinary, inexpensive "C" flashlight batteries will run a unit for up to 300 hours of normal "on" time. Circuitry is especially designed for crisp, clear intelligible communication and the instant operation feature allows tuning of the units off between calls, extending battery life. Use of battery power does away with power cords, allowing each unit to be placed where most convenient. Only two wires are required between the master unit and each remote station. Beautifully styled, the Heathkit Intercom presents a new approach in design. Both master and remote stations have two-piece cases in ivory and turquoise for a rich, quality appearance. Batteries not included. Shpg. Wt. 6 lbs.



HEATHKIT XI-1 (Master)

$27⁹⁵



HEATHKIT XIR-1
(Remote)

$6⁹⁵

Shpg. Wt. 4 lbs.

AC POWER SUPPLY (XP-1)

A permanent power supply for 24-hour operation of the XI-1 Intercom on household current. Converts 110 V. AC to well filtered 12-volt DC output, eliminating the need for batteries. Power supply is small, compact and fits in space normally occupied by batteries.

HEATHKIT XP-1 .... $9.95

• • • • • • • • • •

NEW IMPROVED DESIGN

STEREO-MONO PREAMP KIT (SP-2A, SP-1A)

Get the SP-2A Stereo Preamp kit now, or the SP-1A monophonic version which you can easily convert to stereo whenever you choose by assembling the second channel (C-SP-1A) and plugging it into your SP-1A.

The SP-2A permits stereo, two channel mixing, or either channel monophonic use, and includes a remote balance control.

Six inputs (12 in the stereo version) accommodate tape, magnetic phono and microphone, plus three separate high level inputs. Level controls provided on "mag. phono" and high level inputs. Switch selects NARTB equalization for tape head input, and RIAA, LP or 78 RPM compensation for mag. phono input

HEATHKIT SP-1A (monophonic) Shpg. Wt. 13 lbs. $37.95

HEATHKIT C-SP-1A (not shown) (converts SP-1A to SP-2A) Shpg. Wt. 4 lbs. $21.95

New

HEATHKIT SP-2A (stereo)
Shpg. Wt. 15 lbs.

$56⁹⁵

$5.70 down, $6.00 mo.

• • • • • • • • • •

THE WORLD'S BIGGEST BARGAIN IN A HI-FI AMPLIFIER

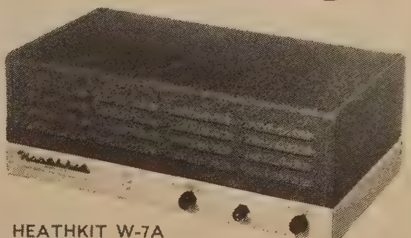
55 WATT HI-FI AMPLIFIER KIT (W-7A)

Utilizing advanced design in components and tubes to achieve unprecedented performance with fewer parts, Heathkit has produced the world's first and only "dollar-a-watt" genuine high fidelity amplifier. Meeting full 55-watt hi-fi rating and 50-watt professional standards, the new improved W-7A provides a comfortable margin of distortion-free power for any high fidelity application.

The sleek, modern styling of this unit allows unobtrusive installation anywhere in the home. The clean, open layout of chassis and precut, cabled wiring harness makes the W-7A extremely easy to assemble. Shpg. Wt. 28 lbs.

SPECIFICATIONS—Power output: Hi-Fi rating, 55 watts; Professional rating, 50 watts. **Power response:** ±1 db from 20 cps to 20 kc at 55 watts output. **Total harmonic distortion:** Less than 2% from 30 cps to 15 kc at 55 watts output. **Intermodulation distortion:** Less than 1% at 62 watts output using 60 cps and 6 kc signal mixed 4:1. **Hum and noise:** 80 db below 55 watts, unweighted. **Damping factor:** Switch on front panel for selecting either maximum (20:1) or unity (1:1). **Output impedances:** 4, 8 and 16 ohms and 70-volt line. **Power requirements:** 117 volts, 50/60 cycles, 90-160 watts. **Dimensions:** 8½" D. x 6⅛" H. x 15" W.

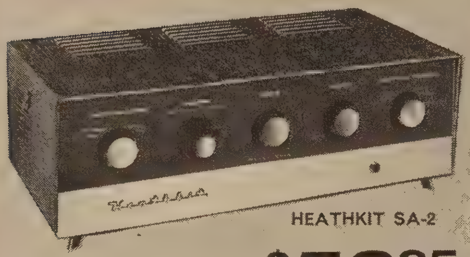
New



HEATHKIT W-7A

$54⁹⁵

New HEATHKIT



HEATHKIT SA-2

$52.95

Stereo Amplifiers

YOUR BEST DOLLAR VALUE IN STEREO...

14/14 WATT STEREO AMPLIFIER KIT (SA-2)

Complete control is at your fingertips with this versatile Stereo Amplifier-Preamplifier. Providing 14 watts per stereo channel, or 28 watts total monophonic, the SA-2 offers every modern feature in a master stereo control center at a price to please the budget minded. The unit offers selection of dual channel stereo operation, monophonic operation using both channels simultaneously, or using either channel for monophonic program material independent of the other channel. A 4-position input selector switch provides choice of mag. phono, crystal phono, tuner, and high level auxiliary input for tape recorder, TV, etc. Other features include RIAA equalization on mag. phono, channel reversing function, clutched volume control, ganged dual tone controls, speaker phase reversal switch and two AC outlets. Handsomely styled black and gold vinyl-clad steel cabinet. Shpg. Wt. 23 lbs.

SPECIFICATIONS—Power output: 14 watts per channel, "hi-fi"; 12 watts per channel, "professional"; 16 watts per channel, "utility". **Power response:** ±1 db from 20 cps to 20 kc at 14 watts output. **Total harmonic distortion:** less than 2%, 30 cps to 15 kc at 14 watts output. **Intermodulation distortion:** less than 1% at 16 watts output using 60 cps and 6 kc signal mixed 4:1. **Hum and noise:** mag. phono input, 47 db below 14 watts; tuner and crystal phono, 63 db below 14 watts. **Controls:** dual clutched volume; ganged bass, ganged treble; 4-position selector; speaker phasing switch. **AC receptacle:** 1 switched, 1 normal. **Inputs:** 4 stereo or 8 monophonic. **Outputs:** 4, 8 and 16 ohms. **Dimensions:** 4½" H. x 15" W. x 8" D. **Power requirements:** 117 volts, 50/60 cycle, AC, 150 watts (fused).

New

HEATHKIT SA-3

$29.95

ECONOMY STEREO AMPLIFIER KIT (SA-3)

This amazing performer delivers more than enough power for pure, undistorted room-filling stereophonic sound at the lowest possible cost. Featuring 3 watts per stereo channel and 6 watts as a monophonic amplifier, the SA-3 has been proven by exhaustive tests to be more than adequate in volume for every listening taste.

You will find its ease of assembly another plus feature. Heathkit construction manuals, world famous for their clarity and thoroughness, lead you a simple step at a time to successful completion of the kit. Larger than life-size diagrams show you exactly what each part looks like, where it goes, and how it is installed.

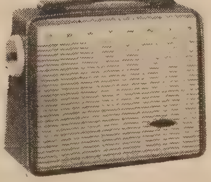
The amplifier is tastefully styled in black with gold trimmed control knobs and gold screened front and rear panel. A tremendous buy at this low Heathkit price! Shpg. Wt. 13 lbs.

SPECIFICATIONS—Power output: 3 watts per channel. **Power response:** ±1 db from 50 cps, 20 kc at 3 watts out. **Total harmonic distortion:** less than 3%; 60 cps, 20 kc. **Intermodulation distortion:** less than 2% @ 3 watts output using 60 cycle & 6 kc signal mixed 4:1. **Hum and noise:** 65 db below full output. **Controls:** dual clutched volume; ganged treble, ganged bass; 7-position selector; speaker phasing switch; on-off switch. **Inputs (each channel):** tuner, crystal or ceramic phono. **Outputs (each channel):** 4, 8, 16 ohms. **Finish:** black with gold trim. **Dimensions:** 12½" W. x 6¾" D. x 3¼" H.

New

HEATHKIT XR-2P
(6 lbs.)

$29.95



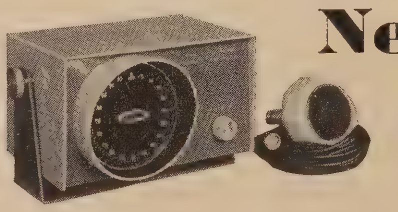
HEATHKIT XR-2L
(7 lbs.)

$34.95

6-TRANSISTOR PORTABLE RADIOS (XR-2P and XR-2L)

New, improved styling, new vernier tuning, up to 1,000 hours on flashlight batteries . . . are just a few of the plus features you get with these new transistor portables. Carry them with you wherever you go; to the beach, on trips, boating, etc. These new, improved models bring you the outstanding performance of the preceding models plus brand new styling and the additional convenience of vernier tuning for smooth, effortless station selection. The XR-2P features a mocha and beige high-impact plastic case. The XR-2L has a sun-tan color leather case with an identical beige plastic front. Six Texas Instrument transistors are used for high sensitivity and selectivity. A large 4" x 6" PM speaker with heavy magnet provides excellent tone quality. The roomy chassis makes it unnecessary to crowd components, adding greatly to ease of construction. The six standard size "D" flashlight batteries used for power provide extremely long battery life and can be purchased anywhere. Fun to build, and fun to use . . . order one today!

New



HEATHKIT DS-1

$69.95

$7.00 DN., $7.00 MO.

- Indicates Depth and Type of Bottom From 0 to 100 Feet
- Detects Submerged Objects (fish, logs, etc.) and Their Depth
- Completely Transistorized . . . Operates From Flashlight Batteries

TRANSISTOR DEPTH SOUNDER (DS-1)

Weekend boatsman or professional . . . fisherman or skindiver . . . here's the depth sounder for you. Depth is indicated by a flashing neon lamp rotating behind a transparent circle in the molded black plastic dial face. A large hood around the dial enables the viewer to easily read the indicator in bright light or sunshine. The transducer uses a barium titanate element mounted in a faired, molded epoxy resin housing with solid brass through-hull fitting and mounting hardware. While designed for permanent mounting on the bottom of the boat, temporary outboard mounting of the transducer is also possible. The completely transistorized circuit operates from 6 flashlight cells and one long-life battery. Comes complete with splash-proof cabinet, hardware and gimbal-type mounting bracket. Shpg. Wt. 10 lbs.

New HEATHKIT Amplifiers & Tuners

A NEW AMPLIFIER AND PREAMP UNIT PRICED WELL WITHIN ANY BUDGET

14-WATT HI-FI AMPLIFIER KIT (EA-3)

This thrilling successor to the famous Heathkit EA-2 is one of the finest investments anyone can make in top quality high fidelity equipment. It delivers a full 14 watts of hi-fi rated power and easily meets professional standards as a 12-watt amplifier.

Rich, full range sound reproduction and low noise and distortion are achieved through careful design using the latest developments in the audio science. Miniature tubes are used throughout, including EL-84 output tubes in a push-pull output circuit with a special-design output transformer. The built-in preamplifier has three separate switch-selected inputs for magnetic phono, crystal phono or tape, and AM-FM tuner. RIAA equalization is featured on the magnetic phono input. Shpg. Wt. 15 lbs.

NOTE THESE OUTSTANDING SPECIFICATIONS—Power output: 14 watts, Hi-Fi; 12 watts, Professional; 16 watts, Utility. **Power response:** ±1 db from 20 cps to 20 kc at 14 watts output. **Total harmonic distortion:** less than 2%, 30 cps to 15 kc at 14 watts output. **Intermodulation distortion:** less than 1% at 16 watts output using 60 cps and 6 kc signal mixed 4:1. **Hum and noise:** mag. phono input, 47 db below 14 watts; tuner and crystal phono, 63 db below 14 watts. **Output impedances:** 4, 8 and 16 ohms.

HEATHKIT EA-3

$29.95

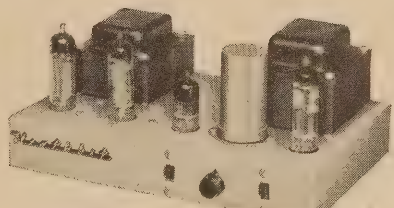
NEVER BEFORE HAS ANY HI-FI AMPLIFIER OFFERED SO MUCH AT SO LOW A PRICE

New

"UNIVERSAL" 14-WATT HI-FI AMPLIFIER KIT (UA-2)

Meeting 14-watt "hi-fi" and 12-watt "professional" standards, the UA-2 lives up to its title "universal" performing with equal brilliance in the most demanding monophonic or stereophonic high fidelity systems. Its high quality, remarkable economy and ease of assembly make it one of the finest values in high fidelity equipment. Buy two for stereo. Shpg. Wt. 13 lbs.

SPECIFICATIONS—Power output: Hi-Fi rating, 14 watts; Professional rating, 12 watts. **Power response:** ±1 db from 20 cps to 20 kc at 17 watts output. **Total harmonic distortion:** Less than 2% from 20 cps to 20 kc at 14 watts output. **Intermodulation distortion:** Less than 1% at 14 watts output using 60 cps and 6 kc signal mixed 4:1. **Hum and noise:** 73 db below 14 watts. **Output impedances:** 4, 8 and 16 ohms. **Damping factor:** Switched for unity or maximum; maximum damping factor 15:1. **Input voltage for 14 watt output:** .7 volts. **Power requirements:** 117 volts 50/60 cycles, 55 watts. **Dimensions:** 10" W. x 6½" D. x 4¾" H.



HEATHKIT UA-2

$22.95

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MORE STATIONS AND TRUE FM QUALITY ARE YOURS WITH THIS FINE TUNER KIT

New

HIGH FIDELITY FM TUNER KIT (FM-4)

This handsomely styled FM tuner features better than 2.5 microvolt sensitivity, automatic frequency control (AFC) with on-off switch, flywheel tuning and prewired, prealigned and pretested tuning unit. Clean chassis layout, prealigned intermediate stage transformers and assembled tuning unit makes construction simple—guarantees top performance. Flywheel tuning and new soft, evenly-lighted dial scale provide smooth, effortless operation. Vinyl-covered case has black, simulated-leather texture with gold design and trim. Multiplex adapter output also provided. Shpg. Wt. 8 lbs.

SPECIFICATIONS—Tuning range: 88 to 108 mc. **Quieting sensitivity:** 2.5 uv for 20 db of quieting. **IF frequency:** 10.7 mc. **Image ratio:** 45 db. **AFC correction factor:** 75 kc per volt. **AM suppression:** 25 db. **Frequency response:** ±2 db 20 to 20,000 cps. **Harmonic distortion:** Less than 1.5%, 1100 uv, 400 cycles 100% modulation. **Intermodulation distortion:** Less than 1%, 60 cycles and 6 kc mixed 4:1 1100 uv, 30% modulation. **Antenna:** 300 ohms unbalanced. **Output impedance:** 600 ohms (cathode follower). **Output voltage:** nominal .5 volt (with 30% modulation, 20 uv signal). **Power requirements:** 105-125 volts 50/60 cycle AC at 25 watts. **Overall dimensions:** 4½" H. x 13¼" W. x 5½" D.

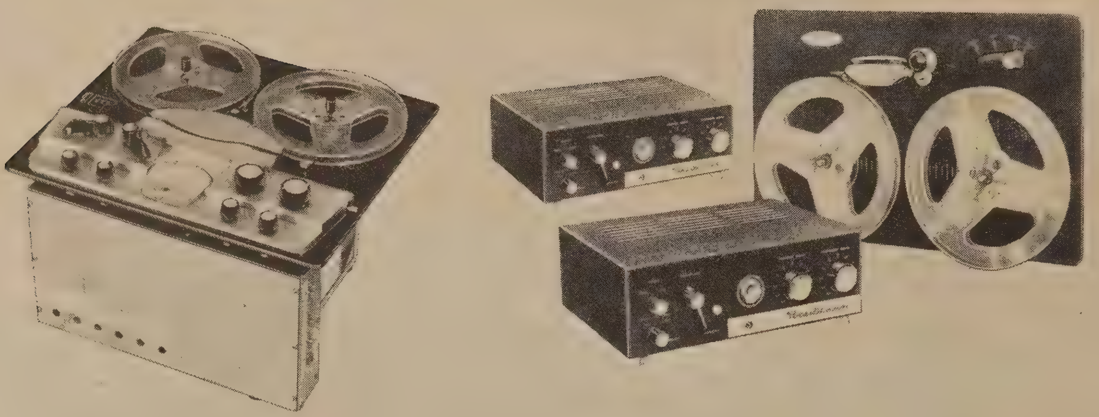
HEATHKIT FM-4

$34.95

HEATH COMPANY/Benton Harbor, Mich.

a subsidiary of Daystrom, Inc.

New HEATHKIT Tape Recorders



- Choice of 3 Outstanding Models
- Compare With $350-$400 Machines
- Preassembled Tape Mechanism
- Choice of Monophonic or Stereo models
- Complete versatility
- Easy to assemble, easy to use

PROFESSIONAL QUALITY TAPE RECORDER KITS (TR-1 Series)

Enjoy the incomparable performance of these professional quality tape recorders at less than half the usual cost. These outstanding kits offer a combination of features found only in much higher priced professional equipment, generally selling for $350 to $400. Not the least of these special features is the handsome styling which characterizes the kits . . . a semi-gloss black panel is set off by a plastic escutcheon in soft gold, which is matched by black control knobs with gold inserts. The mechanical assembly, with fast forward and rewind functions, comes to you completely assembled and adjusted; you build only the tape amplifier. And, you'll find this very easy to accomplish, since the two circuit boards eliminate much of the wiring. Separate record and playback heads and amplifiers allow monitoring from tape while recording and a "pause" control permits instant starting and stopping of tape for accurate cueing and tape editing. A digit counter is provided for convenient selection of any particular recording. Push-pull knob provides instant selection of 3¾ or 7½ IPS tape speed. Safety interlock on record switch reduces possibility of accidental erasure of recorded tapes. Shpg. Wt. 30 lbs.

SPECIFICATIONS—Tape speed: 7.5" and 3.75" per second. **Maximum reel size: 7".** **Frequency response (record-playback):** ±2.5 db, 30 to 12,000 cps at 7.5 IPS; ±2.5 db, 30 to 6,500 cps at 3.75 IPS. **Harmonic distortion:** 1% or less at normal recording level; 3% or less at peak recording level. **Signal-to-noise ratio:** 50 db or better, referred to normal recording level. **Flutter and wow:** 0.3% RMS at 7.5 IPS; 0.35% RMS at 3.75 IPS. **Heads (3):** erase, record, and in-line stereo playback (TR-1C, monophonic playback). **Playback equalization:** NARTB curve, within ±2 db. **Inputs (2):** microphone and line. **Input impedance:** 1 megohm. **Model TR-1D & TR-1E outputs (2):** A and B stereo channels. **Model TR-1C output (1):** monophonic. **Output levels:** approximately 2 volts maximum. **Output impedance:** approximately 600 ohm (cathode followers). **Recording level indicator:** professional type db meter. **Bias erase frequency:** 60 kc. **Timing accuracy:** ±2%. **Power requirements:** 105-125 volts AC, 60 cycles, 35 watts. **Dimensions:** 15½" W. x 13½" D. Total height 10¾". **Mounting:** requires minimum of 8½" below and 1½" above mounting surface. May be operated in either horizontal or vertical position.

MODEL TR-1C Monophonic Tape Deck: Monophonic Record and Playback. **$159.95** $16.00 DWN. $14.00 MO.

MODEL TR-1D Two Track Stereo Tape Deck: Monophonic Record and Playback, plus Playback of 2-track Pre-recorded Stereo Tapes (stacked). **$169.95** $17.00 DWN. $15.00 MO.

MODEL TR-1E Four Track Stereo Tape Deck: Monophonic Record and Playback, plus Playback of 4-track Pre-recorded Stereo Tapes (stacked). **$169.95** $17.00 DWN. $15.00 MO.

MODEL C-TR-1C Conversion Kit: Converts TR-1C to TR-1D (see TR-1D description above). Shpg. Wt. 2 lbs. **$19.95**

MODEL C-TR-1D Conversion Kit: Converts TR-1D to TR-1E (see TR-1E description above). Shpg. Wt. 2 lbs. **$14.95**

MODEL C-TR-1CQ Conversion Kit: Converts TR-1C to TR-1E (see TR-1E description above). Shpg. Wt. 2 lbs. **$19.95**

NOTE: To convert TR-1C to TR-1E, purchase both C-TR-1C and C-TR-1D conversion kits.

STEREO-MONO TAPE RECORDER KITS (TR-1A Series)

Here are the tape recorders the avid hi-fi fan will find most appealing! Their complete flexibility in installation and many functions make them our most versatile tape recorder kits. This outstanding tape recorder now can be purchased in any one of three versions. You can buy the new two-track (TR-1AH) or four-track (TR-1AQ) versions which record and play back both stereo and monophonic programming, or the two-track monophonic record-playback version (TR-1A) and later convert to either two-track or four-track stereo record-playback models by purchasing the MK-4 or MK-5 conversion kits. The tape deck mechanism is extremely simple to assemble. Long, faithful service is assured by precision bearings and close machining tolerances that hold flutter and wow to less than 0.35%. Power is provided by a four-pole, fan-cooled induction motor. One lever controls all tape handling functions of forward, fast-forward or rewind modes of operation. The deck handles up to 7" tape reels at 7.5 or 3.75 IPS as determined by belt position. The TR-1A series decks may be mounted in either a vertical or horizontal position (mounting brackets included). The TE-1 Tape Electronics kits supplied feature NARTB equalization, separate record and playback gain controls and a safety interlock. Provision is made for mike or line inputs and recording level is indicated on a 6E5 "magic eye" tube. Two circuit boards simplify assembly.

MODEL TR-1A: Monophonic two-track record/playback with fast forward and rewind functions. Includes one TE-4 Tape Electronics kit. Shpg. Wt. 24 lbs. **$99.95** $10.00 DWN. $9.00 MO.

TR 1A SPECIFICATIONS—Frequency response: 7.5 IPS ±3 db 50 to 12,000 cps; 3.75 IPS ±3 db 50 to 7,000 cps. **Signal-to-noise ratio:** better than 45 db below full output of 1.25 volts/channel. **Harmonic distortion:** less than 2% at full output. **Bias erase frequency:** 60 kc (push-pull oscillator).

MODEL TR-1AH: Two-track monophonic and stereo record/playback with fast forward and rewind functions. Two TE-4 Tape Electronics kits. Shpg. Wt. 36 lbs. **$149.95** $15.00 DWN. $13.00 MO.

TR-1AH SPECIFICATIONS—Frequency response: 7.5 IPS ±3 db 40 to 15,000 cps; 3.75 IPS ± db 40 to 10,000 cps. **Signal-to-noise ratio:** 45 db below full output of 1 volt/channel. **Harmonic distortion:** less than 2% at full output. **Bias erase frequency:** 60 kc (push-pull oscillator).

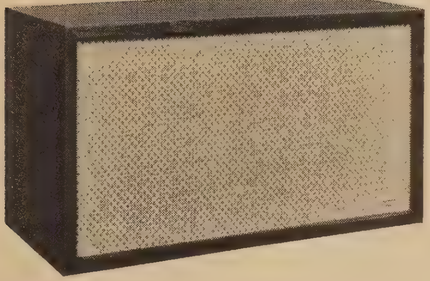
MODEL TR-1AQ: Four-track monophonic and stereo record/playback with fast forward and rewind functions. Two TE-4 Tape Electronics kits. Shpg. Wt. 36 lbs. **$149.95** $15.00 DWN. $13.00 MO.

TR-1AQ SPECIFICATIONS—Frequency response: 7.5 IPS ±3 db 40 to 15,000 cps; 3.75 IPS ±3 db 40 to 10,000 cps. **Signal-to-noise ratio:** 40 db below full output of .75 volts/channel. **Harmonic distortion:** less than 2% at full output. **Bias erase:** 60 kc (push-pull oscillator).

HEATH COMPANY/Benton Harbor, Mich.

a subsidiary of Daystrom, Inc.

New "Acoustic Suspension" Hi-Fi Speaker System Kit



HEATHKIT AS-2U (unfinished)

$69⁹⁵

HEATHKIT AS-2M (mahogany) **$79.95**
HEATHKIT AS-2B (birch) **EACH**

NOW—FOR THE FIRST TIME —EXCLUSIVELY FROM HEATH

ACOUSTIC SUSPENSION HI-FI SPEAKER SYSTEM KIT (AS-2)

A revolutionary principle in speaker design, the Acoustic Research speaker has been universally accepted as one of the most praiseworthy speaker systems in the world of high fidelity sound reproduction. Heathkit is proud to be the sole kit licensee of this Acoustic Suspension principle from AR, Inc., and now offers for the first time this remarkable speaker system in money-saving, easy-to-build kit form.

The 10″ Acoustic Suspension woofer delivers clean, clear extended-range bass response and outstanding high frequency distribution is provided by the specially designed "cross-fired" two-speaker tweeter assembly.

Another first in the Heathkit line is the availability of preassembled and prefinished cabinets. Cabinets are available in prefinished birch (blond) or mahogany, or in unfinished birch suitable for the finish of your choice. Kit assembly consists merely of mounting the speakers, wiring the simple cross-over network and filling the cabinet with the fiberglass included. Shpg. Wt. 32 lbs.

SPECIFICATIONS—Frequency response (at 10 watts input): ±5 db, 42 to 14,000 cps; 10 db down at 30 and 16,000 cps. **Harmonic distortion:** below 2% down to 50 cps, below 3% down to 40 cps at 10 watts input in corner room location. **Impedance:** 8 ohms. **Suggested amplifier power:** 20 watts minimum. **Suggested damping factor:** high (5:1 or greater). **Efficiency:** about 2%. **Distribution angle:** 90° in horizontal plane. **Dimensions:** 24″ W. x 13½″ H. x 11⅜″ D.

New Test Equipment

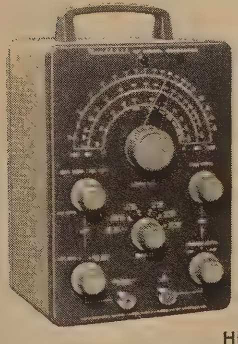
HEATHKIT FMO-1 Price to be announced

AN INSTRUMENT LONG-AWAITED BY SERVICE TECHNICIANS EVERYWHERE!

HEATHKIT FM TEST OSCILLATOR KIT (FMO-1)

Here in one compact, easy-to-use instrument are provided all the test signals and sweep frequencies required for fast, easy alignment and troubleshooting of RF, IF and detector sections of FM tuners and receivers. An instrument unique in the test equipment field . . . being the only one of its type designed especially for FM service work.

SPECIFICATIONS—Output frequencies: for RF alignment, 90 mc (FM band low end), 100 mc (FM band middle range), 107 mc (FM band high end). **Modulation:** 400-cycle incidental FM. **IF and detector alignment:** 10.7 mc sweep. **Sweep width markers:** 200 kc to over 1 mc, variable, 10.7 mc (crystal), 100 kc sub-markers. **Modulation:** 400-cycle AM. **For other applications:** 10.0 mc (crystal) and harmonics, 100 kc, 400-cycle audio. **Controls:** main frequency selector, modulation switch /concentric level control, marker oscillator switch /concentric level control, sweep width—power switch, output control, AF-RF (source impedance) switch. **Power supply:** transformer, selenium rectifier. **Power requirements:** 105-125 V, 50 /60 cycles, 12 watts. **Cabinet size:** 7⅜″ H. x 4¾″ W. x 4⅜″ D.



HEATHKIT RF-1

$27⁹⁵

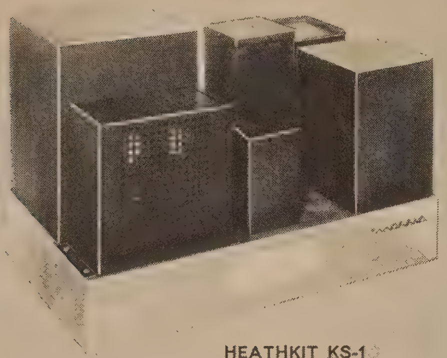
PREASSEMBLED AND ALIGNED BANDSWITCH/COIL ASSEMBLY

RF SIGNAL GENERATOR KIT (RF-1)

Moderately priced, and capable of precision performance the RF-1 provides highly accurate and stable RF signals for trouble-shooting and aligning RF and IF circuits of all kinds. Modulated or unmodulated RF output of at least 100,000 microvolts is available, controlled by both fixed-step and continuously variable controls. A built-in 400 cycle audio generator with 10-volt output provides internal modulation of RF signal and is available separately for audio tests. A preassembled bandswitch and coil assembly, aligned to factory precision standards, eliminates the need for special alignment equipment. Shpg. Wt. 7 lbs.

SPECIFICATIONS—Frequency range: Band A, 100 kc to 320 kc; Band B, 310 kc to 1.1 mc; Band C, 1 mc to 3.2 mc; Band D, 3.1 mc to 11 mc; Band E, 10 mc to 32 mc; Band F, 32 mc to 110 mc. **Calibrated harmonics:** 110 mc to 220 mc. **Accuracy:** 2%. **Output:** impedance, 50 ohms; voltage, in excess of 100,000 uv on all bands. **Modulation:** internal, 400 cycles approx. 30% depth; external, approx. 3 V across 50 k ohm for 30%. **400 cycles audio output:** approx. 10 V open circuit. **Tube complement:** VI 12AT7 RF oscillator, V2 6AN8 modulator and output. **Power requirements:** 105-125 V 50 /60 cycles AC, 15 watts. **Aluminum cabinet dimensions:** 6½″ W. x 9½″ H. x 5″ D.

New HEATHKIT Ham Radio Gear


HEATHKIT KS-1

$169⁹⁵

TOP POWER WITH ECONOMY AND SAFETY

KILOWATT POWER SUPPLY KIT (KS-1)

The KS-1 is designed as a companion to the "Chippewa" Linear Amplifier and is also suitable for supplying plate power to most other RF amplifiers in the medium to high power class. The KS-1 features an oil-filled, hermetically sealed plate transformer to minimize corona, a swinging choke in the filter circuit for good regulation, and a 60-second time delay relay to permit adequate heating of the mercury vapor rectifiers before application of plate voltage. All components are conservatively rated and well insulated for long life and dependable service. Shpg. Wt. 105 lbs.

SPECIFICATIONS—Maximum DC power output: 1500 watts. **Nominal DC voltage output:** 3000 or 1500 volts. **Maximum DC current output:** Average 500 ma, peak 1000 ma. **Regulation:** 180 to 600 ma (typical linear amplifier), 8%; 0 to 300 ma (typical class C amplifier), 10%; 0 to 500 ma, 15%. **Ripple:** Less than 1%. **Tube complement:** (2) 866A mercury vapor rectifiers. **Recommended ambient temperature:** 50 to 100 degrees F. **Circuit:** Two half-wave mercury vapor rectifiers in a full wave, single-phase configuration with swinging choke input filtering. **Line power requirements:** 115 V, 50/60 cycles, 20 amperes; 230 V, 50/60 cycles, 10 amperes. **Chassis size:** 17¾" W. x 12" H. x 13" D.

HEATHKIT KL-1

$415⁰⁰

MOVE TO THE TOP IN TRANSMITTING POWER

"CHIPPEWA" KILOWATT LINEAR AMPLIFIER KIT (KL-1)

The KL-1 operates at maximum legal amateur power inputs in SSB, CW or AM service using any of the popular CW, SSB and AM exciters as a driver. Premium tubes (4—400's) push the "Chippewa" to top performance levels while a centrifugal blower provides more than adequate cooling. Shpg. Wt. 70 lbs.

SPECIFICATIONS—RF section: Driving power required (10 meters); Class AB1 (tuned grid) 10 watts peak; Class C (tuned grid) 40 watts; Class AB1 (swamped grid) 60 watts peak. **Power input:** Class AB1 (SSB-voice modulation) 2000 watts PEP; Class AB1 (SSB-two tone test) 1300 watts; Class AB1 (AM linear) 1000 watts; Class C (CW) 1000 watts. **Power output (20 meters):** Class AB1 (SSB-voice modulation) 900 watts PEP; Class AB1 (SSB-two tone test) 550 watts; Class AB1 (AM linear) 300 watts; Class C (CW) 750 watts. **Output impedance:** 50 to 72 ohms (unbalanced). **Input impedance:** 50 to 72 ohms (unbalanced). **Band coverage:** 80, 40, 20, 15 and 10 meters. **Panel metering:** 0 to 50 ma, grid current; 0 to 100 ma screen current; 0 to 5000 volt plate voltage; 0 to 1000 ma plate current. **Tube complement:** Final tubes, (2) 4-400A; clamp tube, (1) 6DQ6; voltage regulators, (4) OD3, (2) OC3. **Power requirements:** AC (power supply primary circuit), 250 watts, 115 volt, 50/60 cycles; DC, 3000 to 4000 volts, 450 ma. **Cabinet size:** 19½" W. x 11⅝" H. x 16" D.

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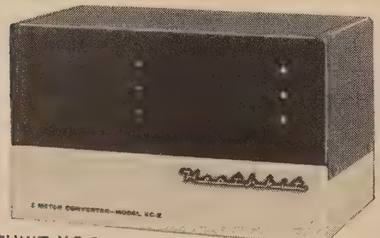
HEATHKIT XC-2

$36⁹⁵

2-METER CONVERTER KIT (XC-2)

Extends coverage of the Heathkit "Mohawk" Receiver to the 2-meter band. May also be used with receivers tuning a 4 mc segment between the frequencies of 22 and 35 mc when appropriate crystal is used. Shpg. Wt. 7 lbs.

SPECIFICATIONS—Noise figure: 4.5 db; 1 uv signal provides 20 db thermal noise quieting. **Sensitivity:** approx. .1 uv input will provide a signal better than 6 db over noise level. **Gain:** approx. 40 db. **Pass band:** essentially flat 144 to 148 mc; approx. 35 db down at 143 and 149 mc. **Image rejection:** better than 100 db (tunable). **Output impedance:** 50 to 75 ohms. **Input impedance:** 50 to 75 ohms; 300 ohms with balun. **Frequency:** input, 144 to 148 mc; output, 22 to 26 mc with crystal supplied. **Tubes:** 6AM4, 6BS8, 6EA8, 12AT7. **Crystal:** .005% 3rd overtone. **Power requirements:** 150 volts DC at 50 ma (dropping resistor supplied for 210 VDC RX-1 operation) 6.3 volts AC/DC at 1.375 amps. **Size:** 9" W. x 5½" H. x 4¾" D.

HEATHKIT UT-1

$28⁹⁵

"BEST BUY" UTILITY POWER SUPPLY KIT (UT-1)

This power supply is ideal for converting the Heathkit "Cheyenne" and "Comanche" mobile transmitter and receiver to fixed station operation; or may be used to provide necessary filament and plate voltage for a wide variety of amateur equipment. Features silicon diode rectifiers, high capacity filters for superior dynamic regulation, and line filtering to minimize TVI and reduce receiver line noise. On ICAS basis, provides 150 watts DC plus filament power for 6.3 volt or 12.6 volt filament applications (6.3 VAC., 8 amps. or 12.6 VAC., 4 amps.; 600 VCD., 250 ma or 600 VDC., 200 ma and 300 VDC., 100 ma). Less than 1% ripple; excellent regulation. Housed in attractive green and gray-green cabinet measuring 9" long, 4¾" wide, 6" high. Shpg. Wt. 15 lbs.

New Citizen's Band Transceiver

WIRED OR KIT FORM

HEATHKIT CB-1
$42⁹⁵
(kit model)

HEATHKIT W-CB-1
$60⁹⁵
(wired model)
$6.10 dwn., $6.00 mo.

Both models include transceiver, crystal, microphone and two special power cords.

- No Tests to Take—No Operator's License Required
- Any Citizen 18 or Older Can Have Own Station
- Hundreds of Business and Personal Uses

CITIZEN'S BAND TRANSCEIVER KIT (CB-1)

The Heathkit CB-1 Citizen's Band Transceiver is a compact radio transmitter and receiver combination designed to operate on the new 11-meter "Citizen's Band". No tests to take, no special knowledge or operator's license required . . . you need only fill out forms we supply, and mail them to FCC to apply for station license. Operates just like any short wave radio used by police and other communication services. Front panel switch selects both "transmit" and "receive". Two or more Heathkit Transceivers provide you with your own 2-way radiotelephone system for making necessary business and personal contacts with family, friends or associates. A Heathkit accessory power supply makes the CB-1 completely portable for use in cars, trucks, boats, etc., using 6 or 12 volt batteries. With appropriate accessory antenna, the CB-1 can be used for communicating between truck and office, home and automobile, boat and shore, farm-house and field . . . literally hundreds of useful applications. Comes complete with microphone, 2 power cords for mobile or fixed operation, station ID card, call letters, and crystal for one channel and FCC application form. Order power supply and antenna separately. Attractively styled in two-tone "mocha" and "beige". Shpg. Wt. 10 lbs.

SPECIFICATIONS—Receiver type: Superregenerative detector w/rf stage. **Power input:** 5 watts maximum to plate of final RF amplifier (FCC requirement). **Transmitter frequency control:** Third overtone type quartz crystal operating within 0.005% of marked channel frequency between −20° and +130° F. **Modulation:** AM plate and screen modulation automatically limited to less than 100% (FCC requirements). **Power supply:** Internal 117 V. 50/60 cycles. AC (35 watts). For 6 V battery power, use Model VP-1-6 Vibrator Power Supply (6.5 amps); for 12 V battery power, use VP-1-12 (4 amps). **Total B+ requirements:** 260 volts at 60 ma; total heater requirements, 6.3 volts at 1.8 amps or 12.6 volts at 0.9 amps. **Power rectifier:** 2 silicon diodes in full wave voltage doubler circuit. **Microphone:** Combination hand-held and desk type, ceramic element, plastic case, with cord and connector. **RF output impedance:** 50 ohms. **Speaker size:** 3½" (round). **Undistorted audio power output:** Approximately 1 watt. **Line cords:** Two supplied, one for AC operation, one for battery operation. Power circuits automatically switched when appropriate line cord is plugged in. **Cabinet dimensions:** 8" H. x 6" D. x 9¾" W.

SPECIFY FREQUENCY CHOICE
(1st and 2nd choice)

CLASS D CITIZEN'S BAND FREQUENCIES

26.965 mc	27.035 mc	27.115 mc	27.185 mc
26.975 mc	27.055 mc	27.125 mc	27.205 mc
26.985 mc	27.065 mc	27.135 mc	27.215 mc
27.005 mc	27.075 mc	27.155 mc	27.225 mc
27.015 mc	27.085 mc	27.165 mc	*27.255 mc
27.025 mc	27.105 mc	27.175 mc	

*This channel shared with Class C Radio Control.

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CBU-1 "UTILITY" ANTENNA...............$9.95
Good coverage, portable antenna for temporary mobile or fixed installations. 45½" base-loaded antenna, 12' connecting cable, mounting bracket and clip. 3 lbs.

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Best coverage mobile installation. Easy to install spring base, ¼ wave, 9' whip; 15' connecting cable and necessary hardware. 7 lbs.

CBF-1 "FIXED LOCATION" ANTENNA...$19.95
Excellent coverage, ¼ wave "ground plane", 9' elements; 50' connecting cable and mounting bracket. 7 lbs.

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6 volt Vibrator Power Supply for use with 6 volt batteries.
KIT—Model VP-1-6. Shpg. Wt. 4 lbs.............$7.95
WIRED—Model WVP-1-6. Shpg. Wt. 4 lbs......$11.95

12 volt Vibrator Power Supply for use with 12 volt batteries.
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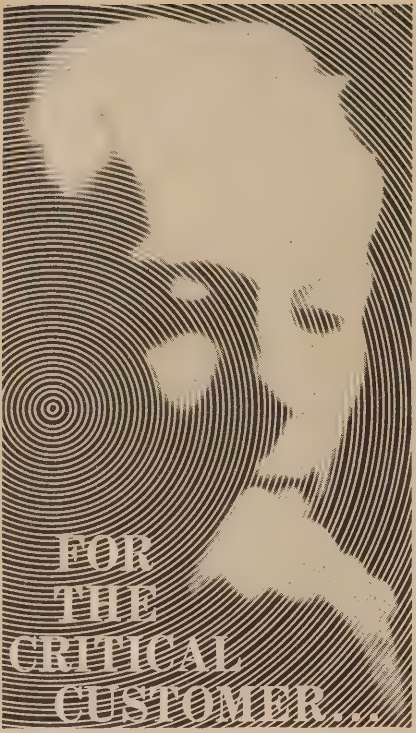

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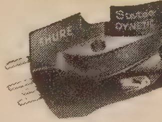

Incomparable quality—the overwhelming choice of independent critics and experts. Floats at only 3 grams in transcription tone arms. Distortion-free response from 20 to 15,000 cps. Superbly designed and built to perfectionist tolerances.

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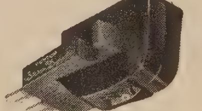

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Literature available:
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SPOTTING VIDEO IF OSCILLATION

By WARREN J. SMITH

OSCILLATIONS in the video if strip possibly produce more inferiority and self-distrust among service technicians than any other fault of TV receivers. Methods of troubleshooting this type of oscillation are usually involved and often time-consuming. This simplified method saves much of the time and most of the worry.

The first question is: When should video if oscillation be suspected? When the audio is normal and the video information is present but not entirely legible. The raster may be streaked with long white lines or have a spotted appearance unaffected by changes in the contrast control setting. The presence of oscillations can be quickly verified by connecting a vacuum-tube voltmeter across the detector load resistor as indicated in the figure. Normal voltage readings at this point, with no input signal, vary from 0.5 to 1, due to the space charge of the detector tube and the small amount of rectified voltage caused by normal disturbances such as noise. Oscillation increases the voltage to some high value. In extreme cases it may read as high as 35 volts.

The exact cause of oscillation is often difficult to determine, but it can usually be attributed to one of two things: misalignment or a defective component in the if strip. It is comparatively easy to correct a misaligned if strip. Oscillations are usually caused by two or more if transformers being tuned too close to the same frequency. The method recommended here is to locate the if transformer that is tuned to the highest frequency and turn the tuning slug all the way out. Next, the transformer that corresponds with the lowest frequency is located and its tuning slug turned all the way in. If one transformer is normally tuned to the center frequency of the bandpass, its tuning slug is approximately centered. Any other if transformers should be adjusted either to a quarter- or halfway position between the others, depending upon their frequency. This will result in an

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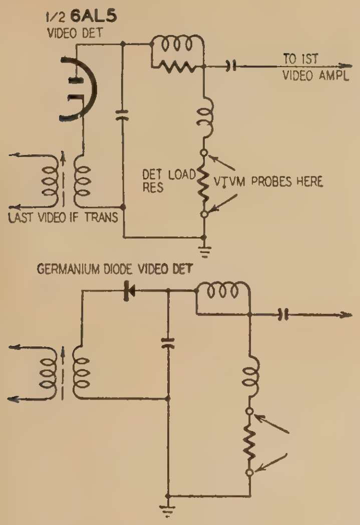

Basic schematic of typical tube and diode TV detector circuits, showing probe placement.

extremely wide response but eliminates any tendency toward oscillation. The alignment can now be finished by following the manufacturer's alignment table for that particular model.

Suppose that after going through the procedure above, oscillation still remains. The voltmeter again indicates an excessive amount of voltage across the detector load resistor as one of the if slugs is adjusted to its normal setting. Then oscillation is attributable to a defective component, a trouble that is often difficult to isolate. A change in value of a loading resistor across an if transformer, a leaky coupling capacitor, an increase in value of plate or grid load resistors are all sources of oscillations. A leaky coupling capacitor permits a portion of the high positive plate voltage to leak over to the grid of the following stage. This positive voltage on the grid reduces the normal bias on the tube and results in excessive gain in the stage, allowing oscillations to develop. An increase in value of grid or plate load resistors permits the Q of the stage to rise above normal, and again excessive gain causes oscillation.

A method for quickly locating the stage in which the oscillations are originating is to bypass the grid of each video if tube with a .001-μf capacitor to ground. The capacitors eliminate the tendency of oscillations to build up and, by removing them one by one (starting at the stage preceding the detector) while observing the voltmeter for an increase of voltage across the detector load resistor, it can be determined exactly in which stage they are being developed. For this purpose several capacitors with short leads and clips should be made up, to save time.

To find the exact cause of the trouble once the stage in which it originates is isolated, measure and compare with the manufacturer's information the plate, grid and cathode voltages of the

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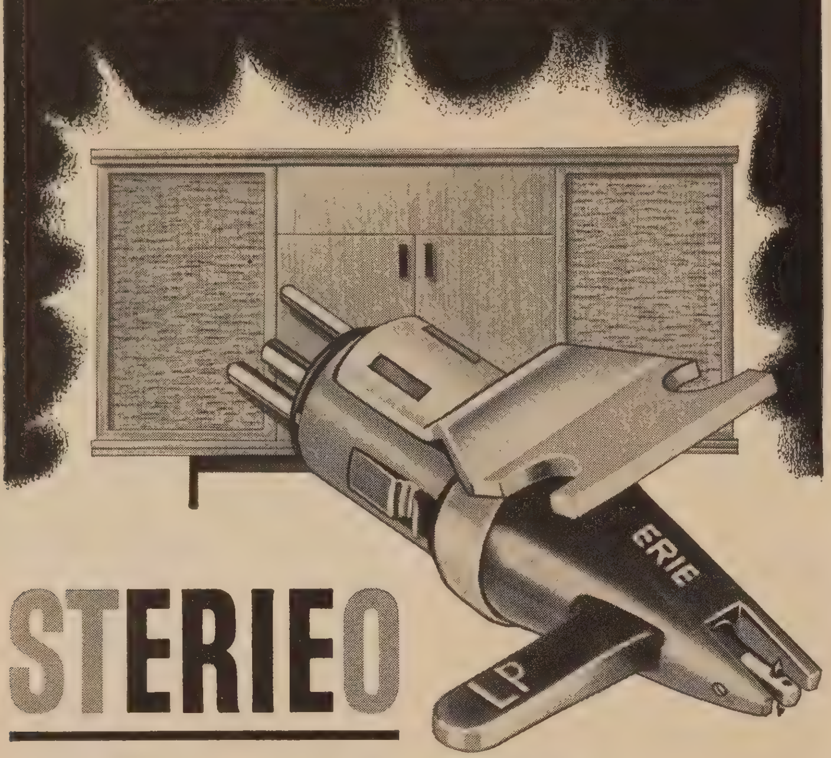

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tube. If the grid voltage measures less negative than normal, a leaky capacitor or gassy tube is indicated. Measure the voltage at either end of the grid load resistor. It should read the same at both points with respect to ground. If not, keep the voltmeter connected to the grid of the tube and remove the tubes on either side of the coupling network. If the bias voltage on the grid still remains less negative than normal, the coupling capacitor is defective and should be replaced. If the voltmeter gives a normal reading after the tubes have been removed, check for a gassy tube by replacing it with one known to be good. If, after replacing the tube, the bias still remains at an abnormal value, resistance tests must be made. Turn off the receiver and allow sufficient time for the tubes to cool off. Then measure the plate, screen, grid and decoupling resistors for a change in value. A deviation up to 10% of the manufacturer's stated values is considered normal. Other possible causes of oscillation are open heater or screen bypass capacitors or an open decoupling capacitor in the plate or grid circuits. Also be sure to check the lead dress—some receivers are very critical. The plate and grid leads must be kept as far apart as possible to prevent undesirable feedback.

The source of trouble is usually found to be a leaky, open or shorted capacitor or a resistor that has changed in value. If none of these defects appear, measure the resistance from grid to ground. It should correspond to the value of the grid load resistor. If it doesn't, remove the leads from the grid terminal and measure the resistance from the terminal to ground. The resistance meter should give an infinite resistance reading—if not, the socket must be replaced, preferably with a low-loss unit. The author has run into this heartbreaking TV oddity several times. It's a real puzzler to the service technician who is unaware of its possibility.

Fortunately, oscillation in video if circuits is not too common a problem. When it does occur, the troubleshooting procedure outlined here may help the service technician to correct the trouble quickly and efficiently. END

TV Service CLINIC

conducted by

JACK DARR

WIDE-BAND TV service oscilloscopes have frequency-compensated step attenuators (Fig. 1). Unless the compensating trimmer capacitors C1, C2 and C3 are properly adjusted, waveform displays will be distorted.

The simplest method of checking the compensating adjustments is shown in Fig. 2. A 20-kc sawtooth voltage is tapped off at a point of suitable level in the scope's horizontal amplifier and fed to the vertical input terminal.

A diagonal-line pattern appears on the scope screen, as seen in Fig. 3-a. The trimmer capacitor on each step of the attenuator is adjusted to display a straight line. Too high a value of compensating capacitance produces the pattern shown in Fig. 3-b. The effect of too little is shown in Fig. 3-c.

Avoid overload. As Fig. 3-d shows vertical amplifier overload will produce kinks at the ends of the line. For this reason, the tapoff point in the horizontal amplifier must be properly chosen.

The same method can be used to adjust the trimmer capacitor in a 10-to-1 low-capacitance probe (Fig. 4). The trimmer is adjusted to display a straight diagonal line on the screen.

Accuracy of this method depends upon freedom from distortion in the scope amplifiers. If the amplifiers distort, different waveforms are applied to the vertical and horizontal plates of the CRT.

Amplitude distortion is plainly evident. On the other hand, frequency distortion is trickier. The sawtooth sweep rate, in any case, should not be increased past the point that waveform displays may show horizontal nonlinearity, as illustrated in Fig. 5.

Lead-in cables

We are installing a three-outlet antenna system in a new home constructed of adobe, with cement-slab floors. The contractor has recommended putting 300-ohm ribbon in a plastic tube and laying it in the cement floors. We are in a fringe area, and our signal levels run from 50 to 100 μv. However, if we could do this, it would certainly simplify the installation. What results could we expect from it?—E. L. P., Escondido, Calif.

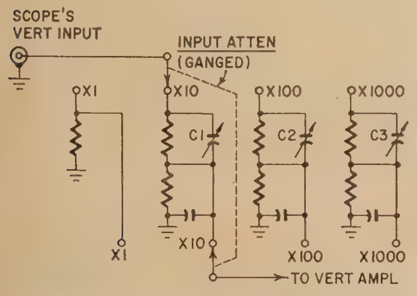

Fig. 1—Typical compensated step attenuator for a wide-band scope.

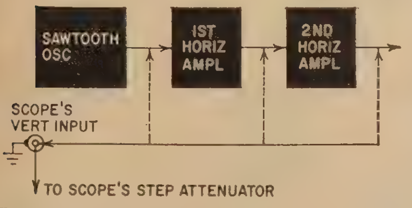

Fig. 2—Sawtooth voltage of suitable value is tapped off scope's sawtooth oscillator and fed to its vertical input.

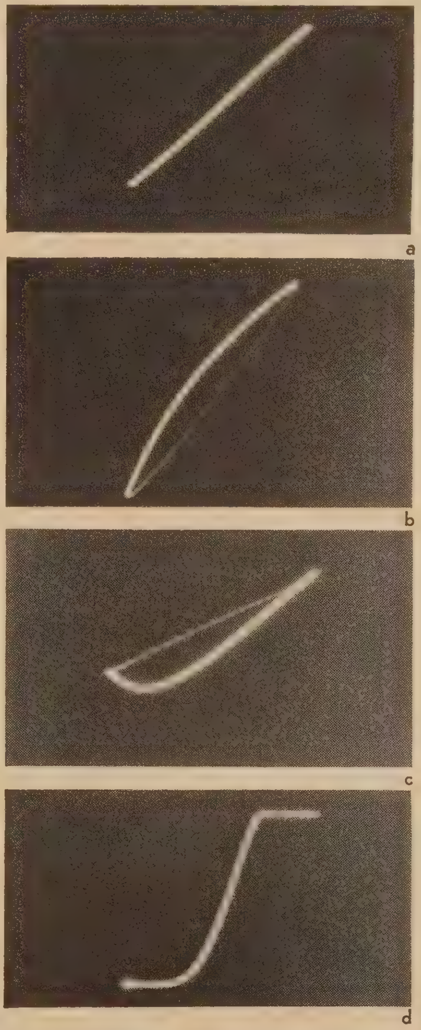

Fig. 3—Waveforms seen on scope screen indicate compensation of step attenuator: a—correct compensation; b—too much compensating capacitance; c—too little compensating capacitance; d—vertical amplifier overloaded, too much input voltage.

You can run the lead-in cable through the cement floors if you wish, but I'm afraid that your losses would be quite prohibitive with standard 300-ohm twin-lead, even encased in plastic tubing. I assume this to mean standard electrical conduit, made of plastic. I believe you will have to use coaxial cable for this, which must still be run through the plastic (or metal, in this case) conduit.

You can get a very neat installation if you run the conduit up through the walls to the point where the tapoff is to be located, and terminate it (the conduit) in a standard electrical outlet box. As the coax is 72-ohm, impedance-matching transformers will have to be used. Jerrold, Blonder-Tongue and many others make 72–300-ohm matching transformers designed to fit standard electrical outlet boxes complete with plastic covers in any color de-

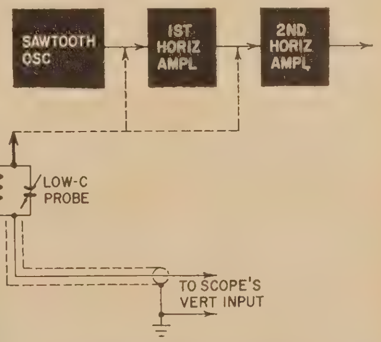

Fig. 4—A low capacitance probe can be adjusted with the help of a sawtooth voltage.

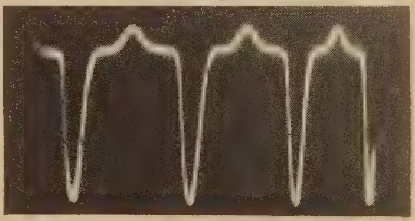

Fig. 5—Waveform display showing horizontal nonlinearity.

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sired and a plug-in connection for the lead-in to the set.

With the signal level you mention, a booster amplifier will be needed near the antenna to raise the signal to a snow-free level, and to make up for the small additional loss incurred by the use of the coax. However, there are distribution amplifiers, such as the Blonder-Tongue DA8-B, which are built specifically for just such applications. This amplifier has a gain of about 10 db, and can supply as many as 8 outlets from a single input. The DA8-B has both 300- and 75-ohm outputs.

For the cable, probably RG59U would be the best and easiest to handle. This cable has a nominal impedance of 73 ohms, and an outside diameter of only ¼ inch. It can be fished through standard ½-inch electrical conduit with ease. If there is insufficient gain, an antenna booster, like the Jerrold *DeSnower* or Blonder-Tongue *AB-1*, with about 26-db gain over all vhf channels will help out greatly.

With careful workmanship, this should make a very neat installation.

Voltage and current waveforms

Why is a voltage waveform different from a current waveform? The book I have on scopes doesn't explain this.— A. M., Windsor, Ont.

A voltage waveform is not different from a current waveform when working with sine waves. On the other hand, when working with complex waves, voltage and current waveforms will always differ in reactive circuits (Fig. 6).

The square wave is a complex wave. It contains a large number of sine waves. In the R-C circuit, each harmonic in the square wave flows as if it alone were present. The high-frequency harmonics are practically short-circuited by the capacitor. Their voltage is accordingly impressed across the resistor. On the other hand, the low-frequency harmonics are practically blocked by the capacitor, and their voltage is impressed across the capacitor. Thus, the waveform across the resistor is the sum of the higher-frequency harmonics in the square wave. The waveform across the capacitor is

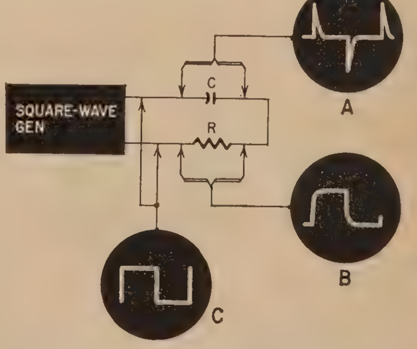

Fig. 6—A is a voltage waveform and B is a current waveform. If we add them, we get the square wave C.

the sum of the lower-frequency harmonics. If you add the waveforms across capacitor and resistor, you recover the original square wave. Any attempt to break the law (Kirchhoff's) will fail. In other words, we could have fallen back on Kirchhoff's law to deduce the complementary shapes of waveforms across resistor and capacitor. Let us look at the circuit again, from the standpoint of voltage and current. The waveform across the resistor shows the current flowing into and out of the capacitor. The waveform across the capacitor shows the voltage drop across it. Current and voltage waveforms accordingly differ in the reactive circuit driven by a complex voltage.

Burning resistors

I am servicing a Packard-Bell 2301 in which the voltage-doubler resistors burn out after several hours of operation. Voltages are OK in the flyback circuit. Higher wattage resistors have been tried.—A. R. S., Seattle, Wash.

There is evidently excessive current drain through the 1-meg resistors (Fig. 7). Check operation with the high-voltage lead disconnected from the 16KP4. The tube may be drawing excessive current. However, if the resistors still burn out, the 500-$\mu\mu f$ capacitors should be checked for leakage. A rough check can be made by disconnecting each capacitor in turn. If the resistors still overheat, check the insulation resistance between the 1B3-GT filament windings and the transformer assembly.

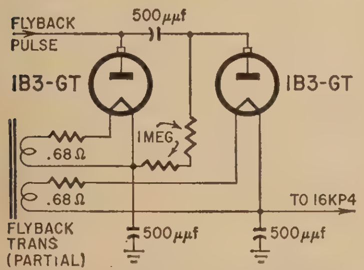

Fig. 7—The 1-meg voltage-doubler resistors will overheat if excessive current is drawn from the high-voltage power supply.

Transient oscillation

We've an RCA KCS-68C chassis which was worked on for a complaint of no high voltage. Replacing a small capacitor in the horizontal oscillator circuit restored the high voltage and the set was delivered. In about a week it was back in the shop. The customer said the picture suddenly pulled in about 4 inches on each side. We've checked all parts in the horizontal sweep and oscillator circuit and all voltage readings seem OK. A puzzling thing to us: if we touch the cap of the 6CD6 with a screwdriver picture width returns to normal! The picture is good, except for the width.—W. S., Detroit, Mich.

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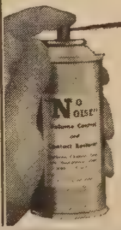

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zontal output tube plate cap with the screwdriver brings back the width. It looks as if you have a case of parasitic oscillation in the 6CD6 plate circuit. Touching the cap is adding enough capacitance to damp out these oscillations. This circuit includes a very small capacitor, a 33-μμf unit connected across two terminals on the flyback. Since this is inside the high-voltage housing on this set, did you check it? You might try taking scope waveforms around the high-voltage circuit, using either a very low-capacitance probe or very loose coupling to the horizontal output tube plate lead to see if you can detect any unusual waveforms.

I believe that replacing the 33-μμf capacitor on the flyback will stop your trouble. If not, try adding 100-ohm resistors in the plate and screen grid leads of the 6CD6. You might also check the width link on the back of the chassis. We have found several cases where the link had corroded and was not making good connections. Clean it up and check the 180-μμf capacitor the link connects across the width coil. You might also try adding about 150–200 μμf across this capacitor. Also try adding a 100-μμf capacitor, rated at least 5 kv, from terminal 2 on the flyback to the chassis.

First and second detectors

What is the difference in operation between the first detector and the second detector? Both act as nonlinear devices, as both produce beat frequencies. The second detector also cuts off the negative portion of the video if signal. Hence, the first detector also cuts off the negative swing of the if signal. Why detect the if signal, when it has already passed through the first detector?—O. T., Los Angeles, Calif.

The first detector (mixer) and the second detector (picture detector) are both nonlinear resistances. It is helpful to regard the mixer from the standpoint of generating a difference frequency (the difference between the rf and the local-oscillator frequency). This is a frequency translation. The fact that rectification occurs in the mixer is beside the point. The if amplifier is tuned to the difference frequency (23 or 45 mc), and the video-frequency component is rejected. Of course, we can see this video-frequency component if we connect a scope to the "looker point" on the tuner. Now, the if signal is still a high-frequency modulated carrier. Before the modulation envelope can be passed through the video amplifier, the 23-mc (or 45-mc) if signal must be rectified in the picture detector. The output from the picture detector is a low-pass filter, with a response from dc to 4.5 mc (Fig. 8).

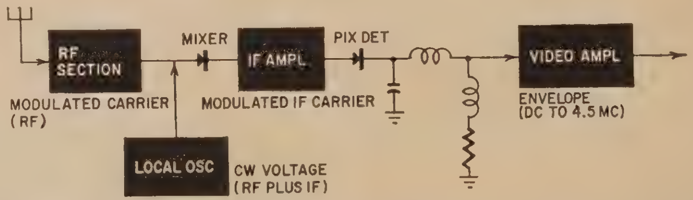

Fig. 8—Both the mixer and the pix detector are rectifiers. However, the mixer passes a difference beat frequency to the if amplifier, while the pix detector passes the modulation envelope to the video amplifier.

Double trouble

I have a couple of questions. A Philco 51T 2130 TV I am working on comes on with a Christmas-tree effect for a few seconds, then the picture snaps into sync. Also, after it has been on for about 5 minutes, it begins to pull horizontally, tearing the picture at times. Then the vertical pulls down slowly out of sync. When I put a .004-μf capacitor on pin 6 of the video amplifier (12AV7) or pin 6 of the 12AU7 second sync separator, the picture locks in perfectly. What is the reason for this?—E. J. S., St. Louis, Mo.

Here we are again concerned with the correct adjustment of the horizontal oscillator. Your Philco uses a stabilized multivibrator. The effect has several names: Christmas-treeing, mode-hopping, squegging, etc., but it is all the same thing. The horizontal oscillator is trying to operate (momentarily) at the wrong frequency and the correction circuit is yanking it back on frequency bodily! This is happening several times per second, causing the peculiar effect. I would suggest running a complete realignment of the horizontal oscillator circuit. If this chassis has the extra horizontal oscillator centering control (some runs in this series did, others did not) adjust it so the oscillator will run and lock a picture in with the ringing coil shorted out. Then adjust the ringing coil for a stable picture.

The other trouble is obviously sync. From the symptoms, it seems that video is leaking into the sync. Replace the 12AV7 sync amplifier no matter how it tests on a tube tester! These tubes are *very* critical in the circuit used here. Also, check the plate load resistors for each stage—sync and video amplifier—and the small coupling capacitors between each stage. If any of these has even the slightest leakage, it will change the bias on the sync separators and really fix things up for you!

In some versions of this circuit, a small capacitor was installed between the 12AV7 input grid and the chassis. It bypassed some of the signal's high-frequency video component and improved sync action. If it gives a permanent improvement, put a small capacitor there and leave it. Try several

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Thousands of service technicians already save thousands of hours every day with the amazing B&K Television Analyst. Enables you to inject your own TV signal at any point and watch the resulting test pattern on the picture tube itself. Makes it quick and easy to isolate, pin-point, and correct TV trouble in any stage throughout the video, audio, r.f., i.f., sync, and sweep sections of black & white and color television sets—*including intermittents.* Makes external scope or wave-form interpretation unnecessary. Enables any serviceman to cut servicing time in half, service more TV sets in less time, really satisfy more customers, and make more money. Color generator provides both rainbow pattern and color bars.

MODEL 1075 TELEVISION ANALYST. Complete with standard test pattern, white dot, white line, and color-bar slide transparencies, and one clear acetate. Net, $259.95

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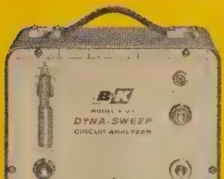

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Tracks down troubles in the horizontal and vertical output circuit including defective output transformer and yoke; checks for shorted turns, leakage, opens, short circuits, and continuity. Includes unique high-voltage indication. Eliminates trial and error replacements.

Model A107 Dyna-Sweep. Companion unit for use only with B&K Model 1075 Television Analyst for driving source. **Net, $49.95**

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of great importance to technicians

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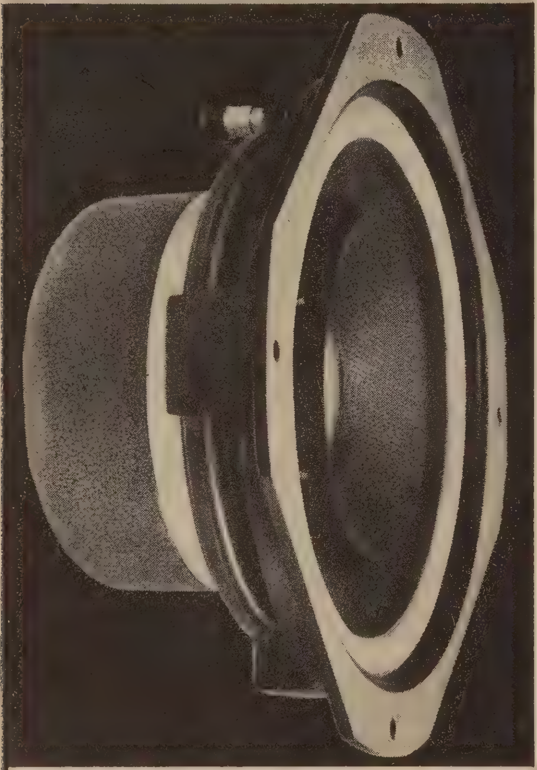
LINEAR-EFFICIENCY
PRECISION LOUDSPEAKERS



The new JBL Linear-Efficiency transducer, combining long linear excursion with relatively high efficiency, is engineered for sealed enclosure or infinite baffle installation. It is a development of great significance to the electronic technician because:

...it is an ideal replacement speaker;

...it can be readily mounted in a wall;

...it gives true precision reproduction in the small space frequently required in stereo installations;

...it does not require excessive power for full-range reproduction.

Sound from any existing system, except those employing the very best loudspeakers, can be greatly improved, easily, with the JBL Linear-Efficiency speaker because enclosure dimensions are not critical, and acoustical requirements can be readily met. The mounting flange is designed so that the speaker can be mounted from the front, or the rear, of the baffle—wall or enclosure. An enclosed volume of only two cubic feet, or more, is recommended.

The efficiency of the LE drivers is such that 20 watts is more than sufficient power for home use. However, the dynamic range of these long-throw speakers permits the use of much more powerful amplifiers.

Super 8" JBL MODEL LE8 (illustrated left) shows a flatness of response from 30 to 15,000 c.p.s. that is without precedent in a unit of this size. Impedance: 16 ohms. Flux: 223,500 Maxwells. Power capacity: 20 watts continuous program. Free air cone resonance: 37 c.p.s. Frame: rigid cast aluminum. Baffle hole diameter (front mounting): 7⅛". Shipping weight: 11 lbs.

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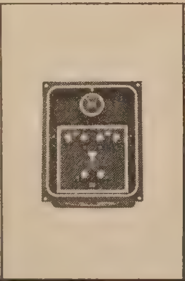
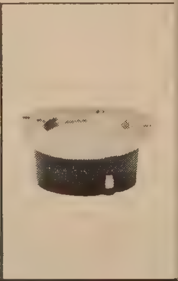
JBL MODEL S5 includes a super 10" JBL MODEL LE10 Low Frequency Driver with free air cone resonance of 15 c.p.s; JBL MODEL LX3 Dividing Network for crossover at 1.000 c.p.s; JBL MODEL LE30 High Frequency Driver, a 5½ octave direct radiator. These three units form an integrated. perfectly matched, electro-acoustical system; they must be used with each other.





JBL

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Los Angeles 39, California

values, around 100–500 μμf, and use the one that gives the best sync locking.

Anti-ringing capacitor

Why does a 56-μμf capacitor across the high side of the horizontal deflection coils minimize ringing bars?—H. B., Palisade Park, N. J.

During flyback, a 10-μsec pulse of several hundred volts is applied to the horizontal yoke windings. The pulse waveform has a high harmonic content.

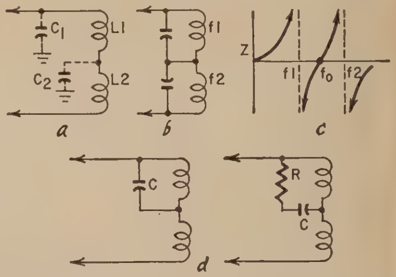

Fig. 9—Yoke ringing: a—Yoke windings L1 and L2 are tuned to parallel resonance by stray capacitances C1 and C2: b—equivalent yoke circuit is that of two parallel-resonant circuits connected in series: c—Whenever two parallel-resonant circuits (having different resonant frequencies) are connected in series, there is a series-resonant frequency f_0 between parallel-resonant frequencies f1 and f2: d—Small capacitor C (left) or capacitor and resistor (C and R) (right) are used to tune the higher-frequency coil to the same resonant frequency as other coil. R is damping resistor which makes adjustment less critical.

The horizontal windings (L1 and L2 in Fig. 9) are tuned by stray capacitances C1 and C2. The windings are loosely coupled, and form a pair of parallel-resonant circuits, connected in series with each other. That is, we have the equivalent circuit shown in Fig. 9-b, resonant at two slightly different frequencies, f1 and f2. Whenever two such circuits are connected in series, the impedance curve shows a series-resonant frequency f_o, between f1 and f2, as indicated in Fig. 9-c. When pulsed, strong ringing occurs at the series-resonant frequency—Z is low and this harmonic frequency causes a strong current flow at f_o. As shown in Fig. 9-d, we use a small capacitor, or capacitor and resistor, to tune both windings to the same frequency, and eliminate f_o.

16- to 21-inch screen

I would like to convert a Sentinel 1U416.416 and an Arvin 3160 to a 17- or 21-inch picture tube. The Sentinel now has a 16GP4, and the Arvin is using a 16AP4.—H. K. L., Chicago, Ill.

A 21EP4 can be swept satisfactorily by the Sentinel chassis. No component changes are required, although the picture will be a bit dimmer on the larger screen. Converting the Arvin chassis may require a change of flyback and yoke, depending upon whether adequate high voltage is available, and whether the present yoke is a 70° type. END

fm tv dx in 1959

Part II

By ROBERT B. COOPER, Jr.

FM dxer Bruce Elving still maintains his comfortable lead in the run for top honors in the FM dxing ranks with a whopping total of 346 FM stations heard in Duluth, Minn. But even with this tremendous total, Elving managed to log 14 new dx hauls in one short 26-hour period —Aug. 18–19. Elving found many Ohio, Michigan, New York and Pennsylvania FM stations rolling into his Duluth location—600-800 miles.

Wayne Baer, Meyersville, Pa., is another ardent FM dxer, and a pretty good hand with weak signals in the video range, too. Baer's report of WHAD-FM, Delafield, Wis., on Sept. 11 is one of several FM dx hauls noted during the year in which one or two FM stations in the 400–700-mile range snuck in while no other signs of FM dx were present. WHAD-FM is 575 miles from dxer Baer.

And TV dxer David Beal of Tucson uses a 1947 model FM tuner to do his dxing. His list of 24 FM calls includes 20 E-skip stations logged during the last 6 weeks of the TV dx skip season this summer.

Oct. 9–10, 1959

Followers of the regular TV and FM Dx column will remember the excitement passed on from this desk to dxers regarding the expected potential of the Oct. 9–10 period as a very unusual meteor shower date. It was scheduled for the reappearance of the Giacobinids meteor shower, associated with the 13-year orbital pattern of the Draconid comet. During the comet's last pass close to earth in 1946, astronomers recorded a very vivid meteor display. Therefore, astronomers and ionospheric physicists assumed this year's scheduled return of the 13-year comet would bring a recurrence of the 1946 display.

But sadly, nothing or very little, if anything, occurred. The shower was not only poor, it was almost nonexistent as showers go.

But despite all the lost sleep, at least one dxer considered his efforts well rewarding. John Cody, dxing from Middletown, Conn., did see a few good bursts. Cody, like so many others, felt the high-band channels deserved the most watching, and watch he did. First from 6 am to 4 pm EST on the 9th and then, after a rest, back at the dials from 1:30 am until 9 am on the 10th—17.5 hours of dial twisting and blank screen watching which netted him a new station and much experience.

Even with the burst count running below an average shower count, but slightly above normal, Cody nabbed high-bander WLOF-TV, channel 9, Orlando, Fla., 1,150 miles. WLOF-TV was logged on two bursts, the first at 3:43 am, the second at 3:55 am. And we emphasize that this was done during a time segment when burst counts (the number of meteor bursts per minute) were only average.

WLOF-TV was helping those observing the expected shower by staying on with test pattern and tone (dx tests like this, and others, will be one of the many regular features of the new hobby magazine, *TV-FM Dxing Horizons*). Although 17.5 hours may seem like a lot of hours to watch for two short bursts from one new station, to dxer Cody and hundreds like him it is

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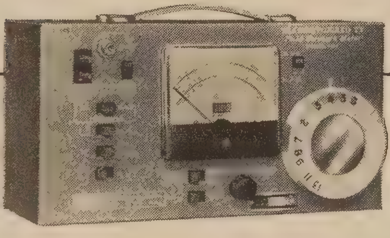
time well spent for such a rare catch.

TV dxer of the year

In last year's tabulated standings of the members of the Over 50 TV Dx Club, dxer John Cody was 9th with 165 calls to his credit. At that time, Cody was fast approaching the point where additional new loggings would come slowly, especially from a location where he sits with his back virtually to the Atlantic, and only 180° of horizon available for dxing purposes. So Cody turned to meteor scatter, watching the high band almost exclusively when the low band was jumping with burst signals from stations 700 to 1,200 miles distant, and his high-

1959–60 OVER 50 DX CLUB

Number of Stations	Dxer	Location
282	Barney Rauch	Peoria, Ill.
249	David Janiowak	Milwaukee, Wis.
218	John Cody	Middletown, Conn.
201	Bill Eckberg	Walnut, Ill.
185	Gary Ehresman	South Bend, Ind.
172	Bob Cooper	Modesto-Fresno, Calif.
161	James Gould	Kokomo, Ind.
160	Jim Himes	Joes, Colo.
159	R. H. Gordon	Harrisburg, Pa.
152	Gary Olson	Barrington, Ill.
142	Walter Owen, Jr.	Springfield, Ohio
136	John T. Sowders	Richmond, Ky.
133	Donald Ruland	Holly Hill, Fla.
132	Stanley J. Penc	Utica, N. Y.
130	Frank Wheeler	Erie, Pa.
129	Dibrell Ingram, Jr.	Conway, Ark.
124	Ed Prond	Dolton, Ill.
123	Gary Rahn	Owen Sound, Ont., Canada
118	Jack Collier	Arlington, Va.
111	Franklin G. Brown	Easley, S. C.
109	David Beal	Tucson, Ariz.
107	Wayne Baer	Meyersville, Pa.
105	Paul Petosky	Trout Lake, Mich.
103	Bill McCarl	Moline, Ill.
103	Ronald Boyd	Truro, N.S., Canada
101	Leon Elliston	Dallas, Tex.
100	James Buchmann	La Crosse, Wis.
100	Rod Luoma	Detroit, Mich.
98	Roger Brown	East Lansing, Mich.
96	Ron Pugh	Fort Bragg, Calif.
92	J. M. Majdak, Jr.	Brattleboro, Vt.
85	Dave Novick	Wauwatosa, Wis.
83	Morris Foote	Middleton, Idaho
83	Jim Dillon	Regina, Sask., Canada
83	Chris Carlisle	Watertown, N. Y.
80	M. L. Whitson, Jr.	Los Alamos, N. M.
78	David Hanson	Washburn, Wis.
76	Russell Cain	Reno, Nev.
74	A. Coro Jr.	Marianao, Cuba
72	Merwyn Dowden	Chester, Va.
69	Bryan Rawlings	Montreal, Que., Canada
69	David S. Roberts	Royal Oak, Mich.
69	Doyne C. Warren	Little Rock, Ark.
67	Richard Bergen, 3rd	La Grange, Ky.
67	Lawrence Molish	Winnipeg, Manitoba, Canada
65	Bert Nuber	Ft. Lauderdale, Fla.
64	Harley Hurlburt	Bennington, Vt.
64	D. W. Parsons	Port Allen, La.
61	Julius Boosi	South Bend, Ind.
59	John Dranchak	Bridgeport, Conn.
57	Richard Zwirko	New Haven, Conn.
56	Thomas Rathke	Clintonville, Wis.
54	Bill Hauser	Oklahoma City, Okla.
53	H. Korb	North Bay, Ont., Canada
53	David Webb	Springfield, Mass.
51	Peter J. Layne	Las Cruces, N. M.
51	Barton Cronin	Ontario, Ore.
	FM Dx Listing	
330	Bruce Elving	Duluth, Minn.
114	Wayne Baer	Meyersdale, Pa.
103	Bill Finn	Milwaukee, Wis.
65	Harold Moensterman	Evansville, Ind.
55	Dale Chute	Toronto, Ont., Canada
41	D. G. Bennie	Kinston, N. C.
40	John Ebeling	Minneapolis, Minn.
21	David Beal	Tucson, Ariz.



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- provides accurate (± 3 db) signal strength readings
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- for probing and orienting antenna signals and measuring distribution systems
- checks horizontal synchronizing frequencies in TV receivers

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band results have been very interesting.

During the Perseids meteor shower in mid-August, he parlayed a single burst on channel 7 into two separate station identifications, at 9:30 EST on Aug. 12. The first was from KHQA-TV, 979 miles in Missouri; the second from KWWL-TV, 914 miles away in Iowa. Two new stations on channel 7, by meteor burst, were both logged on a single burst. It has not been uncommon to log two, perhaps even three, stations on a single burst on the lower channels (2 to 6), but to the best of our knowledge this is the first case of such skill on the high band (channels 7–13).

During a special dx test on Aug. 17, Cody nabbed channel 12, WRDW-TV, Augusta, Ga., a neat 757-mile haul via bursts on long-haul ground wave.

On Aug. 21, Cody watched ground wave extend south first into Virginia, then farther, into North Carolina and, finally, South Carolina! South Carolina high-bander WIS-TV, channel 10, Columbia, at 691 miles was followed by WBTW, channel 8, Florence, 640 miles. Many dxers would consider a high-band haul of 320 miles good dx, but Cody's log for Aug. 25 shows the notation, "WBAL-TV, channel 11, Baltimore, 320 miles overridden by WTVD, 11, Durham, N. Car., 520 miles!" Cody concludes his August report with the comment, "Best month I have ever seen for TV dxing" and, with 11 new stations to his credit in August, many of them high-banders at that, his end-of-August total of 217 was impressive indeed. TV dx is where you find it, and dxer Cody has certainly found it on the plains of New England!

Dxing Horizons

As stated in the January issue, this is the last appearance of this column in RADIO-ELECTRONICS. Realizing for some time that eventually the TV–FM dxing clan would have to strike out on its own, the groundwork for a magazine exclusively for dx has been laid and the first issue of *TV-FM Dxing Horizons* scheduled for January, 1960. It is devoted in its entirety to long-range TV and FM reception, concerning itself with construction articles, feature stories and columns of reports on the many varied dxing activities. This is your opportunity to get behind a magazine devoted to your hobby; it has grown to the point where it must support itself or sink from view. If you have not received your January issue, send for a sample copy of *TV-FM Dxing Horizons.* (820 Tully Road, Modesto, Calif.)

Speaking once again for the hobby of FM and TV dx reception, I would like to express the thanks of thousands of dxers who through the years have found in the RADIO-ELECTRONICS column information simply not available in any other major circulation magazine. To RADIO-ELECTRONICS, thanks for this regular space and for the assist in getting this hobby launched. END

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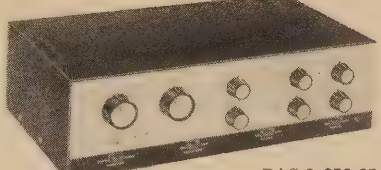

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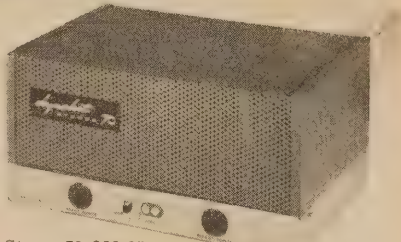

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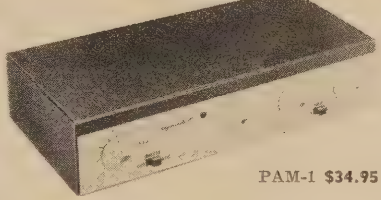

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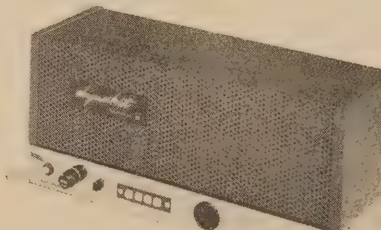

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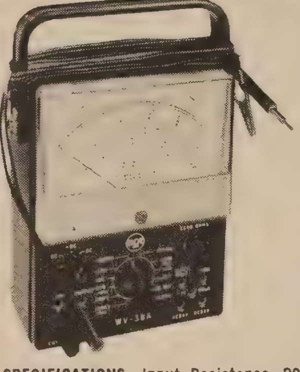

RCA WV-38A (K)

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Exclusive features make this RCA VOM kit the buy of a lifetime! Extra 1-volt and 0.25 volt (250 mv) ranges for wider usage in transistor servicing—new handle clip accommodates probes and test leads for extra carrying convenience. Assembles in a breeze!

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SPECIFICATIONS: Input Resistance—20,000 ohms per volt on DC; 5,000 ohms per volt on AC • Accuracy—± 3% DC, ± 5% AC (full scale) • Regular Scales—2.5, 10, 50, 250, 1000, 5000 volts, AC and DC; 50 μa 1, 10, 100, 500 ma, 10 amps (DC) • Extra Scales—250 mv. and 1 volt (dc) • Frequency Response—AC-flat from 10 cycles to 50 Kc (usable response at 500 Kc) • Ohms—3 ranges: Rx1—(0-2,000 ohms); Rx100 (0-200,000 ohms); Rx10,000 (0-20,000,000 ohms) • Dimensions—W. 5¼", H. 6⅞", D. 3⅛"

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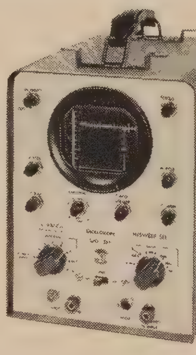

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FEATURING: voltage-calibrated frequency-compensated, 3 to 1 step attenuator • scaled graph screen and calibrating voltage source for direct reading of peak-to-peak voltages • "plus-minus" internal sync...holds sync up to 4.5 Mc • shielded input cable with low capacitance probe included • weighs only 14 pounds • includes built in bracket to hold power cord and cables.

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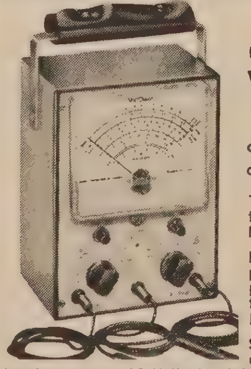

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FEATURING: ohms-divider network protected by fuse • ultra-slim probes and flexible leads • sleeve attachment on handle stores probes, leads, power cord • separate 1½ volts rms and 4 volts peak-to-peak scales for accuracy on low ac measurements • front-panel lettering acid-etched.

SPECIFICATIONS: Measures: DC Volts—0.02 volt to 1500 volts in 7 overlapping ranges; AC Volts (RMS)—0.1 volt to 1500 volts in 7 overlapping ranges; AC Volts (peak-to-peak)—0.2 volt to 4000 volts in 7 overlapping ranges; Resistance—from 0.2 ohm to 1000 megohms in 7 overlapping ranges. Zero-center indication for discriminator alignment • Accuracy—± 3% of full scale on dc ranges; ± 5% of full scale on ac ranges • Frequency Response—flat within ± 5%, from 40 cycles to 5 Mc on the 1.5, 5, and 15-volt rms ranges and the 4, 14, and 40-volt peak-to-peak ranges • DC Input Resistance—standard 11 megohms (1 megohm resistor in probe).

*User Price (Optional)

See them all at your local RCA Test Equipment Distributor!

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RADIO CORPORATION OF AMERICA

ELECTRON TUBE DIVISION HARRISON, N.J.

TV Minus Rf

By L. M. DILLEY

HOW to repair a television set without tools, test equipment, parts or tubes—this was my dilemma on a recent stormy winter evening while visiting friends in the country.

I arrived to find a mood of gloom among the small fry of the household. The TV had "gone dead." I consented to look at the set—a 17-inch Zenith table model. It was showing a bright raster and the usual slight hiss was audible from the speaker.

I removed the back and chassis with a nail file and a rusty pair of gas pliers. A visual inspection revealed no glow in the second video if, a 6CB6—the type tube used in all three if stages and in two sockets of the turret tuner.

To check the apparently dead if tube, I substituted a 6CB6 from the rf section. A faint picture appeared, accompanied by a fair amount of sound. This gave me an idea.

I asked my host for a short piece of small-diameter wire and he produced a length of rusty soft-iron stovepipe wire. I cut two 4-inch lengths, scraping one end of each with the nail file. One length of the wire was then wrapped with one thickness of cellophane tape, the wires laid parallel and tightly twisted together to form a capacitor. I separated the two cleaned ends slightly and inserted them into the socket holes normally occupied by pin No. 1 (grid) and pin No. 5 (plate) of the 6CB6 in the rf stage.

That did it! The sound came up with a boom, and the picture became sharp and contrasty with very little snow. The set gave good pictures on all three available channels. In fact, the owner claimed that performance on channel 8 was as good as it had ever been.

The payoff occurred the following week when a local technician was called to replace the missing tube. He was surprised how well the set performed without it. After removing the gimmicked stove-wire capacitor, he came up with this learned pronouncement: "The reason your friend used iron wire was because it's magnetic. This caused it to work nearly as well as a tube." END

EASING FOCUS ADJUSTMENTS

To adjust a TV's focus controls for hair-line scanning lines, hold a magnifying shaving mirror near the screen of the set while focus adjustments are being made. The size of each individual scanning line will be greatly magnified, making it easier to pinpoint them quickly and accurately.—*J. A. Compton*

New Products and Developments Provide
More TV Signal Power Anywhere—On Any Number of Sets

BLONDER-TONGUE

World's Most Complete Line of TV Signal Amplifiers

New Product

ALL-CHANNEL TV-FM AMPLIFIER
MODEL HAB

Applications: Better TV and FM Reception on 1 to 29 TV sets.

Features: FG* input • High gain . . . 22 db (12.5 times) on low TV and FM bands • 24 db (16 times) on high TV band • NS† terminals and solderless 75 ohm cable connector • Input and Output . . . 75 or 300 ohms • 0.7 volts RF and 1.4 volts RF maximum output at 75 and 300 ohms respectively. List **$62.50**

New Product

BROADBAND AMPLIFIER
MODEL MLA-b

Applications: For Better VHF TV Reception on 30 to 150 TV sets.

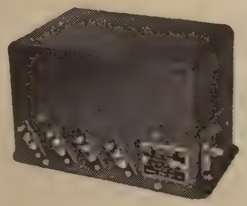
Features: FG* input • High gain . . . 40 db (100 times) • 1.7 volts RF maximum output • Frequency response ± 1 db, on both bands, ± 0.5 db for any TV channel, each band • Variable gain and tilt controls for each band • Solderless 75 ohm radiation-proof coax fittings. List **$142.50**

New Product

ALL-CHANNEL MASTER TV AUTOMATIC GAIN CONTROL AMPLIFIER, MODEL MAC

Applications: Better TV Reception In Large Master TV Systems.

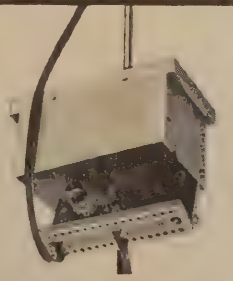
Features: Less than 1 db output variation for 10 db change in input, ± 0.5 db for any TV channel. Compensates for signal and system variations • Controlled variable insertion gain ± 10 db • For use with amplifier with over 16 db gain and output voltage of 0.6 to 2.5 volts RF (such as MLA-b).



ALL-CHANNEL DISTRIBUTION AMPLIFIER, MODEL DA8-B

Applications: Better TV Reception on 3 to 8 sets.

Features: 8 isolated 75 ohm or 300 ohm TV outlets from a single 75 ohm or 300 ohm input • 10 db gain on all channels at each outlet • 22 db isolation • Low noise, all triode circuitry • Variable 20 db gain control prevents system overload. List **$94.50**



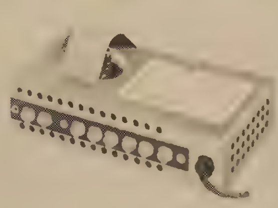
VHF ANTENNA BOOSTER, MODEL AB-2

Applications: Home and other small installations. Mast-mounted amplifier.

Features: FG* inputs • Gain . . . 10 db on all TV channels • Weather-protected "swing-down" chassis • NS† terminals • Boosts signal before line loss develops • Remote power supply • Single transmission line handles AC and signal power. List **$53.95**

FM ANTENNA BOOSTER, MODEL AB-FM

Same as Model AB-2 except improves FM reception in all signal areas. 16 db gain over entire 88 to 108 mc band. List **$53.95**



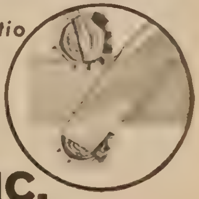
TWO-SET POW-R BOOSTER
MODEL B-24

Applications: Home and small TV installations — 1 to 4 sets.

Features: FG* input • 10 db gain on low band and 7 db on high band for 1 set operation, 3 to 5 db for 2 sets, and "No-Loss" for 4 set hook-up with BT A-104, four set coupler • NS† terminals • On/Off switch • Built-in power supply • No tuning required. List **$24.95**

*FG *Latest premium type frame-grid input circuit provides highest possible signal-to-noise ratio*

†NS *'NO-STRIP'-Exclusive B-T 300 ohm No-Strip terminals for speedy, secure positive installation.*



Available at parts distributors. For further information write Dept. RE-2.

BLONDER-TONGUE LABORATORIES INC.

9 Alling Street, Newark 2, New Jersey

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hi-fi components • UHF converters • master TV systems • industrial TV cameras • FM-AM radios

HOW TO BUILD A STEREO CONSOLE THAT REPRODUCES MUSIC AS FAITHFULLY AS SEPARATELY MOUNTED COMPONENTS

For many years, serious music lovers have searched for a way to enclose high quality high-fidelity equipment in a cabinet that would match their finest furniture.

Until now, there was no practical solution. You had to compromise. You had to sacrifice the best possible music reproduction if you wanted a good looking cabinet. If you insisted on high quality reproduction, you chose components, some of which may not have been quite so appealing to the eye.

If you dislike compromise, Stromberg-Carlson's new kind of console will interest you. We call them Integrity Series Component Ensembles—and to an uncompromising music lover each word in that name will be significant.

At the start, we faced the same problem that every console manufacturer has tried to overcome: when full-range speakers were rigidly mounted in the same console as high quality components, there was a serious loss of sound quality.

This loss—most often recognized as muddy or boomy noise—is caused by "feedback." It occurs because sensitive components can detect the speaker vibrations which are fed back through the body of the cabinet. These vibrations are amplified with the music and reproduced as noise.

If you own a console now, but do not hear these noises, it is not because your ears are insensitive.

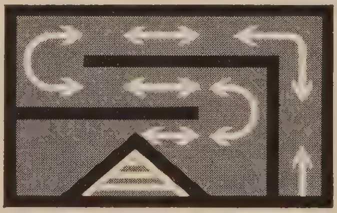
You do not hear them because we and every other console manufacturer had to eliminate them by compromising the musical reproduction of your console. You do not hear them because the sound you hear is not complete.

HOW TO BUILD A CONSOLE THAT ELIMINATES FEEDBACK NOISES

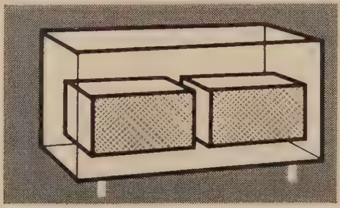
As we analyzed the problem, we realized there were seven projects that we had to accomplish before we could bring you this new kind of console.

PROJECT #1 **The first consideration was given to our components.** They had to have high quality reproduction. The standards we set for them can be most simply described by the phrase "Integrity in Music Reproduction." If you are familiar with Stromberg-Carlson stereo tuners, amplifiers, turntables and speakers, we believe you will agree they earn this description.

PROJECT #2 **Speaker systems were the next important project.** For our new kind of stereo console we needed two speaker systems of unquestionable quality. We were fortunate here, because we had already developed a system that met the quality requirements, the well-regarded Acoustical Labyrinth® Speaker System. Its quarter wavelength duct enclosure, properly coupled to a low-frequency radiator, achieved a system resonance lower than the unbaffled free air cone resonance of the radiator itself. This is the kind of quality we knew you wanted.



PROJECT #3 **To reduce the size of high quality speaker systems so that they would fit into a stereo console of reasonable dimensions.** We were certain that component-quality sound in a console could only be achieved with speaker systems that did not depend on the console cabinet for their enclosure. This meant that we had to reduce the size of the Acoustical Labyrinth enclo-

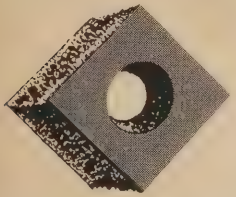


sure so that we could fit two separate speaker enclosures within a cabinet that had reasonable dimensions. It was not easy, but we did it. After many, many trials and tests we achieved the correct size without sacrificing one iota of the extremely linear and extended response of the system.

NOW THE MOST DIFFICULT PROBLEM HAD TO BE FACED

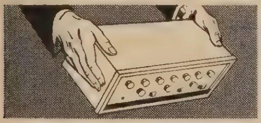
PROJECT #4 **To effectively eliminate feedback by effectively eliminating the mechanical coupling that allows it to occur.** Instead of treating the symptoms, we treated the cause. We developed a method of effectively isolating the speaker systems from the sensitive components. (As a result, Stromberg-Carlson Integrity Series Ensembles are the first successful uncompromised ensembles.)

The key development is what we call Iso-Coustic Speaker System Mounting. This mounting, in which the resistance and compliance to vertical and horizontal pressures have been carefully engineered, has solved the problem. It allows Stromberg-Carlson to create a cabinet-within-cabinet suspension system which prevents transmission of speaker vibrations to the sensitive components. If you component owners could put your equipment into a cabinet whose speaker systems have our Iso-Coustic Mounting, the quality of the sound you'd hear would be as good as your component system is now. In fact, the components we use are the same ones you would choose for your separately mounted component system. They are interchangeable.



INTEGRITY SERIES WILL NEVER BECOME OBSOLETE

PROJECT #5 **To assure the purchaser of an Integrity Ensemble that his choice would never be obsolete,** we designed the units in accordance with a *modular concept*. All of the components are *completely interchangeable*. You can replace any component in the ensemble to keep pace with new developments—without ever replacing your fine cabinetry.



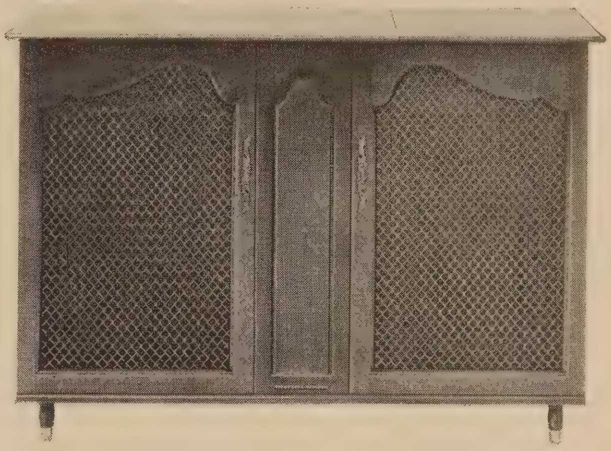
CABINETRY HAD TO BE EXCEPTIONAL, TOO

PROJECT #6 **To design cabinets with the permanent beauty of fine furniture.** Federico responded to the challenge by creating cabinetry in Traditional, Contemporary, Early American, Italian Provincial, French Provincial and Oriental styling. You choose from 16 basic models in these styles, in a choice of finishes. These cabinets, like a fine painting, best describe themselves. They must be seen.

PROJECT #7 **To give you maximum flexibility in your enjoyment of an Integrity Series Ensemble.** Every ensemble provides for your listening tastes and room acoustics by including the Stereo Choice Switch for precise regulation of stereo separation, with or without separate matching speaker systems. All ensembles provide space for adding a tape deck.

You may select your own Stromberg-Carlson stereo components or choose a recommended component complement—in any case Stromberg-Carlson components are always interchangeable.

If you now own a console or components, we invite you to exercise your critical judgment by listening to an Integrity Series Ensemble. (You will find that the better component shops—as well as the better department and music stores—have chosen to feature this new kind of stereo console.) Listen carefully. Look closely. Ask questions. Then accept not our judgment, but your own.



INTEGRITY SERIES COMPONENT ENSEMBLES

—three hundred and fifty dollars to about six thousand dollars. You may choose from 16 models in Traditional, Contemporary and Period stylings, each tastefully designed by Federico. You may select your own Stromberg-Carlson components or choose a recommended Stromberg-Carlson component complement—in any case Stromberg-Carlson components are always interchangeable.

For a complete color catalog of Integrity Series Component Ensembles and components write Stromberg-Carlson, Special Products Division, 1478 N. Goodman St., Rochester 3, New York.

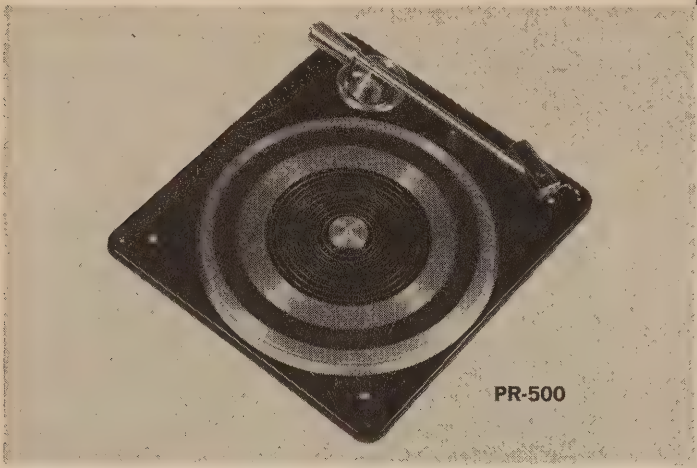
"There is nothing finer than a Stromberg-Carlson"

STROMBERG-CARLSON
A DIVISION OF **GENERAL DYNAMICS**

For integrity in music...

A NEW STROMBERG-CARLSON SINGLE-SPEED TURNTABLE

...in component systems
...in Integrity Series Ensembles



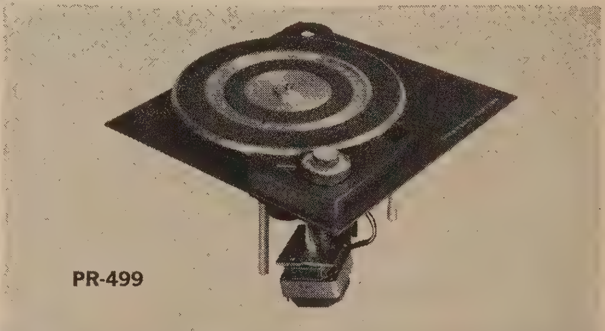
PR-500

PR-500 SINGLE SPEED Here is a revolutionary concept in turntable design: a dual-drive system consisting of two hysteresis-synchronous motors operating one belt drive.

The motors are spaced exactly 180° apart. Any variation of speed is automatically corrected by the interaction of the motors and the impregnated belt. Rumble and noise are virtually eliminated by the belt drive and a unique suspension system in which the tone arm and table, as a unit, are isolated from the mounting board.

Single, 33⅓ speed. Includes tone arm. PR-500, black and brushed chrome $69.95*

PR-499 "PERFECTEMPO" ALL SPEEDS The "Perfectempo" incorporates every valid, time-proven design principle: belt drive; continuously variable cone drive (14 to 80 rpm); stroboscopic speed indicator; dynamically balanced, weighted table; precision motor; plus Stromberg-Carlson's original double-acting motor and table suspension system that effectively eliminates unwanted noise. Performance proves it: Wow 0.14% rms; Flutter 0.09% rms; Rumble −55 db re 20 cm/sec at 1 kc. PR-499, morocco red with aluminum trim $99.95*



PR-499

RA-498 TONE ARM The Stromberg-Carlson Tone Arm uses the most valid engineering concepts of tone arm design. Single pivot point suspension, true viscous damping and high moment of inertia result in extremely low resonance and consequently yield flat response below the limits of audibility. A calibrated counterweight is adjustable to provide any needle point force. For stereo operation, complete with mounting base, viscous fluid, rest, and cartridge clip. Fits all standard turntables. RA-498 .... $24.95*

RA-498

**Prices audiophile net, turntables less bases.*

"THERE IS NOTHING FINER THAN A STROMBERG-CARLSON"

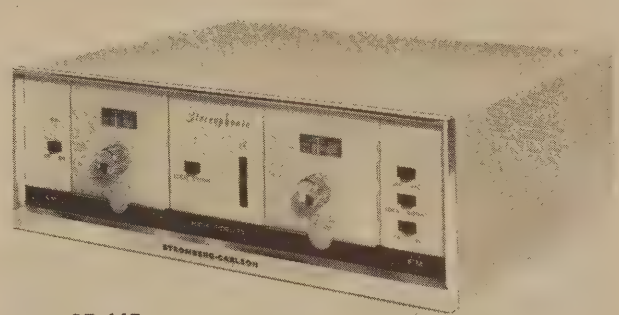
For integrity in music...

THREE NEW STROMBERG-CARLSON TUNERS

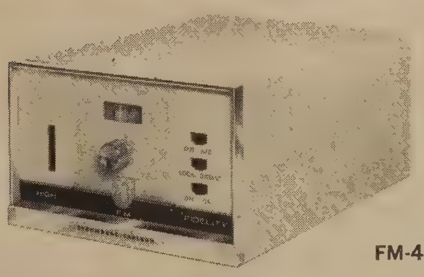
...in component systems
...in Integrity Series Ensembles

SR-445 AM-FM STEREO TUNER The SR-445 is actually two separate and complete units which have been placed together for convenience of mounting and use. They have individual circuitry in which no duplicate use of tubes or circuits is involved. Operate as an AM tuner, an FM tuner or together as an AM-FM stereo tuner. The SR-445 combines the separate AM and FM tuners described below. The specifications are exactly the same as listed for these two units. SR-445 .... $129.95*

All three tuners are available in gold and white or black and brushed chrome. Top cover in white, black, tan or red available at extra cost.

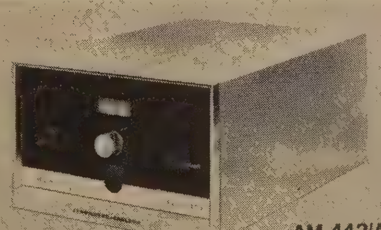


SR-445



FM-443

FM-443 FM TUNER Exceptionally sensitive, low noise reception due to the wide peak-to-peak separation (475 kc) and long, linear slope (350 kc) of the balanced ratio detector, and the grounded grid cascode front end. Sensitivity is 2 uv for 20 db quieting, 4 uv for 30 db quieting (300 ohm). Local-Distant Switch results in 2 uv for 40 db quieting on local stations. Dial station selector and "hair-trigger" tuning eye. Temperature controlled circuits eliminate drift. Includes switched AFC circuit. Tuning Range: 88-108 mc. Bandwidth: 200 kc. Frequency Response: 20-20,000 cps. Self-powered with auxiliary power for AM-441 tuner. Provision for multiplex adapter. FM-443 .... $79.95*



AM-442/AM-441

AM-442 AM TUNER For exceptional AM reception, this tuner has a frequency response of 20-7,000 cps, down 7 db at 7,000 cps. It features a tuned RF stage and 3-gang variable tuning condenser. Its tuning range is 540 to 1,600 kc; Bandwidth is 9 kc. Local-Distant Switch adds 20 db quieting on local stations. Adjustable ferrite loop and external antenna. AM-442 .... $59.95*

AM-441 AM TUNER Same as above, but without its own power supply $49.95*

**Prices audiophile net, zone 1, less cover*

STROMBERG-CARLSON
A DIVISION OF **GENERAL DYNAMICS**

For integrity in music...

STROMBERG-CARLSON STEREO CONTROL AMPLIFIERS

...for component systems
...for Integrity Series Ensembles

HIGH FIDELITY STEREOPHONIC CENTER
STROMBERG-CARLSON

ASR-433

ASR-433 STEREO "24" CONTROL AMPLIFIER A dual channel amplifier with excellent performance and control features. Each channel provides 12 watts of exceptionally clean, balanced power. The exclusive "Stereo Tone Balance" signal permits you to adjust the two channels by a single tone.

The deliberately conservative specifications include: frequency response 20-20,000 cps; harmonic distortion less than 1% at full output; IM distortion less than 1% at program level; hum and noise 63 db down. Inputs: magnetic and ceramic phono; tuner; tapehead; auxiliary/tape. Available in gold and white or black and brushed chrome. ASR-433 . . $129.95*

ASR-444 STEREO "60" CONTROL AMPLIFIER offers all desirable controls, plus high power. Each channel provides 30 watts of balanced power. It features separate bass, treble and volume controls for each channel, a master gain and loudness control, and the "Stereo Tone Balance" signal. Specifications: frequency response 20-20,000 cps; harmonic distortion less than 0.7% at full output, IM distortion less than 1% at program level. Same inputs as ASR-433. In gold and white or black and brushed chrome.
ASR-444 . . . . $169.95*

STROMBERG-CARLSON

ASR-444

ASR-333 STEREO CONTROL AMPLIFIER, and a fine ceramic cartridge, give you quality performance at a low price. This amplifier—with 12 watts per channel—was designed for optimum reproduction with ceramic cartridges. It features tone and volume controls for each channel, plus a loudness control. Frequency response, noise level, distortion, same as ASR-433. Inputs: ceramic phono, tuner, tape/auxiliary. In black and brushed chrome.
ASR-333 . . . . $99.95*

STROMBERG-CARLSON

ASR-333

Prices Audiophile net, Zone 1, less top covers, which are available in white, black, tan or red.

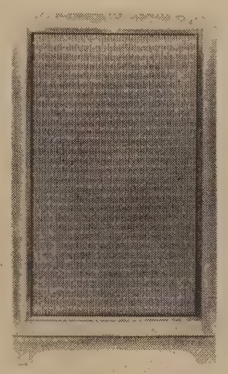
"THERE IS NOTHING FINER THAN A STROMBERG-CARLSON"

For integrity in music...

STROMBERG-CARLSON SPEAKERS AND SYSTEMS

...for component systems
...for Integrity Series Ensembles

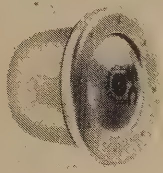
Stromberg-Carlson manufactures a full line of speakers and the famous Acoustical Labyrinth® Speaker System. This system enclosure achieves a system resonance that is lower than the unbaffled free air cone resonance of the low frequency radiator. It utilizes mass loading and frictional damping as acoustical devices to extend the low frequency range of the system with extreme flatness of response. Five new complete speaker systems with a variety of decorator housings are now available. We suggest that you compare the quality of their performance with similar equipment. You be the judge.



DECORATOR HOUSING
RH-469

SPEAKER SYSTEM
RS-405

RW-486

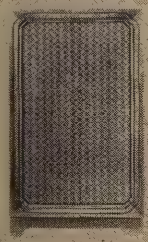


RT-477

RF-484

SPEAKERS Stromberg-Carlson loudspeakers include tweeters, woofers, coaxials and mid-range transducers. They are available in all popular sizes and price ranges.

The unusual Stromberg-Carlson "Slimline" feature allows maximum versatility in installation, and is made possible by another feature: the new "Barite" ceramic magnet, which is used to insure excellent transient response over the full effective frequency range.



RH-465

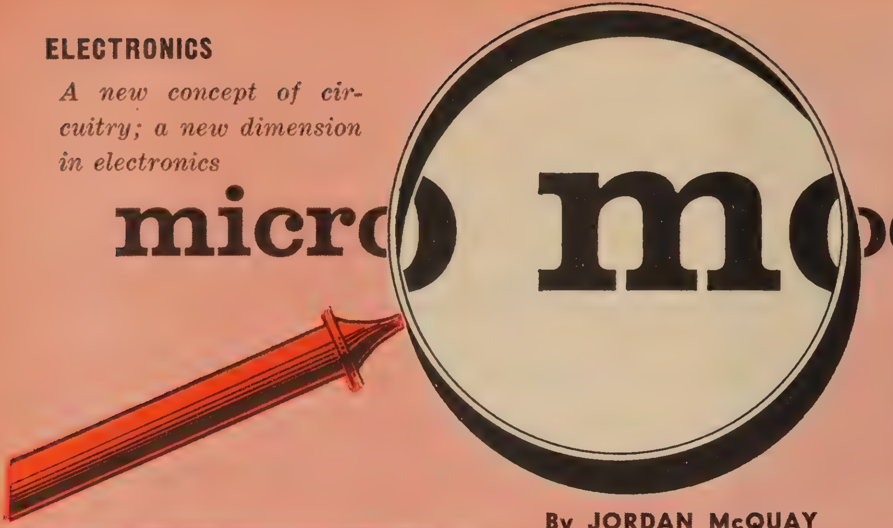
RH-467

ENCLOSURE KITS Acoustical Labyrinth enclosures are now available as unassembled kits. All pieces are precision-cut to size, ready to assemble. Nails, glue, complete instructions—everything you need is included. Enclosures are available for 8", 12" and 15" systems. The same decorator housings available for factory assembled systems may be used. Write for full details on speakers and housings available.

For full details on Stromberg-Carlson components, write Stromberg-Carlson, a Division of General Dynamics, 1478 N. Goodman St., Rochester 3, N. Y.

STROMBERG-CARLSON
A DIVISION OF **GENERAL DYNAMICS**

A new concept of circuitry; a new dimension in electronics



micromodules...
today and tomorrow

By JORDAN McQUAY

THERE'S something new, radically new, in electronics: *micromodules.*

These tiny, precision devices—each smaller than a cube of sugar—provide the same circuit functions but are *10 times* smaller and lighter than conventional electronic equipment.

More than a new idea, the micromodule is a completely different and revolutionary concept of electronics design and construction. It's a unique concept—utilizing *micro*miniaturization and other advanced techniques. It's a dramatic concept—providing tremendous potentialities wherever size, bulk and weight of equipment are critical.

The notion of micromodules was spawned from critical military requirements for lighter-weight smaller communications and electronics equipment, for use aboard satellites and space vehicles of today and tomorrow.

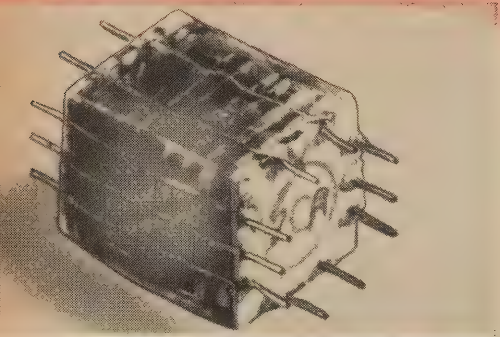


Fig. 1 (top left)—A typical micromodule.

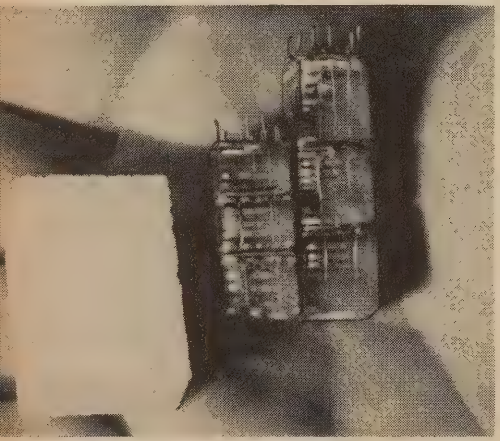


Fig. 2 (left)—Complete circuit of a 7-stage micromodule superhet receiver—and a lump of sugar

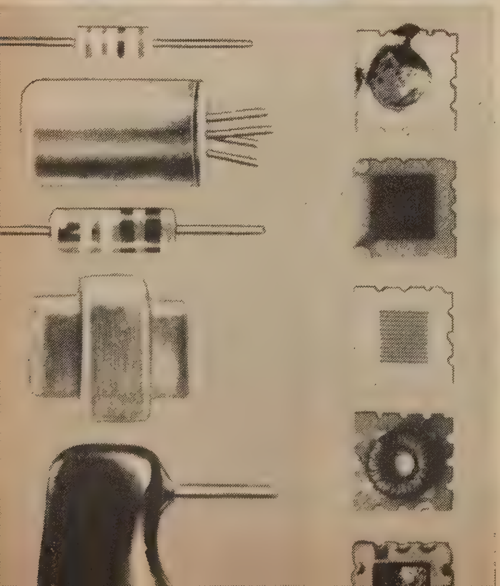


Fig. 3 (bottom left)—Conventional components (left) and equivalent micro-elements (right). Top to bottom: diode, capacitor, resistor, inductor, capacitor.

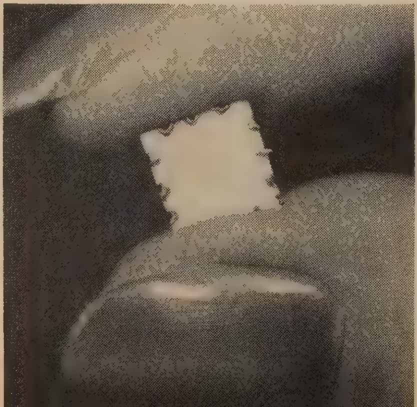


Fig. 4 (below)—Ceramic wafer upon which every micro-element is constructed.

Figs. 1, 3 RCA photos. Figs. 2, 4 Army Signal Corps

Over a year ago, the Army Signal Corps initiated a major research and development program for micromodules, but leaned heavily on the communications–electronics industry for help. A $5-million development contract was awarded to RCA. Subsequently, a dozen other companies have joined the program—which will continue for several years.

Although the concept of micromodules has immediate military value, it will be applied, to some degree, to all kinds of communications and electronics equipment and systems.

The joint military–industry program has progressed with amazing speed. The first results can now be described, some of them for the first time in a national magazine.

Characteristics

A micromodule (Fig. 1) consists of a number of waferlike *micro-elements,* which are stacked and interconnected. All micro-elements have the same shape and size—3/10 inch square—and represent the ultimate in microminiaturization to date. A micro-element may consist of a resistor, capacitor, inductor, transistor, diode or other element—or it may be a combination of several such circuit elements.

Appropriate micro-elements are arranged according to the desired circuit—for an oscillator, amplifier or other stage—and are encased permanently, thus losing their individual identity. The result is a small, cube-shaped solid—a micromodule—which is actually a complete aggregate, ready to function as an oscillator, filter, counter, amplifier or other electronic stage.

Equipped with tiny leads, a number of micromodules can be connected in combinations to provide a variety of circuits for radio transmitters and receivers, audio amplifiers, pulse devices, data computers and many other kinds of electronic equipment (Fig. 2). In every such application, micromodularized equipment will be about one-tenth the size and weight of conventional equipment.

With the plug-in method of connecting micromodules, maintenance and repair is greatly simplified. Individual micromodules can be removed and analyzed separately with automatic test equipment currently under development. Faulty modules can simply be replaced without repair. Ultimate cost of a micromodule will be so low that it will be more economical to replace a defective one than try to repair it.

Entirely new manufacturing processes will develop with universal acceptance of micromodules. With the introduction of automation in their manufacture, there will be a substantial increase in dependability. And mass production will lower the cost of these devices far below that of similar equipment of conventional manufacture.

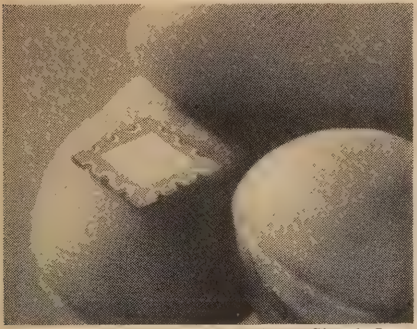

Army Signal Corps

Fig. 5—Ceramic capacitor as a micro-element.

This is the broad program—the basic concept of micromodules—a revolutionary development and a new dimension in electronics.

Many certain advances of the future are still on designers' drawing boards and many developments will require much additional research and engineering. But astounding advances have been made during only the first year of concerted military–industry effort. This is particularly true of the research, design and fabrication of the first micro-elements—the foundation blocks of every micromodule.

Micro-elements

Over a dozen basic types of micro-elements have been perfected. These families include resistors, ceramic and electrolytic capacitors, inductors, transformers, diodes and crystals (Fig. 3). Many others are under development. Within a few years there will be at least 35 families, representing about 135 design types.

Every micro-element is constructed on or within a single ceramic wafer 3/10 inch square and 1/100 inch thick (Fig. 4). Each tiny slab of insulating material is precision-cut, with 12 notches around its outer edge. These notches are for terminals to facilitate assembly and construction.

Micro-element resistors range in value from 10 ohms to 1 megohm. There are two types. In one, a vacuum deposit

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of metal film is first placed on the surface of a wafer, and then the desired resistor pattern is mechanically scribed to any precise value. In the second type, a tin oxide resistance film is deposited as a series of lines which can be terminated in various ways to provide different values of resistance. In either type, as many as four resistors of diverse value can be accommodated on a single wafer.

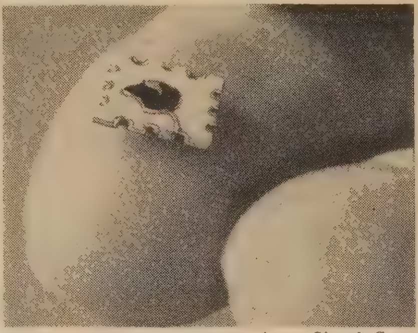
Army Signal Corps

Fig. 6—A diode as a micro-element.

Unlike conventional capacitors which assume a variety of shapes and sizes, all micro-element capacitors are the size of a standardized wafer. General-purpose units, having values up to 0.2 µf, are formed by a coating of conventional high-K dielectric ceramics (Fig. 5). Higher values of capacitance are obtained with multi-layer coatings of film-thin ceramics. Tiny electrolytic structures with solid electrolyte are used for micro-element capacitors to provide values from 0.1 to 10 µf. Precision capacitors, having values up to several thousand µµf, are constructed with dielectric materials of conventional, precision, temperature-compensating ceramics.

Micro-element inductors and transformers consist of toroidal windings on ferromagnetic cores attached to an insulating wafer. They range in value from a few microhenries to as high as 10 mh. The success of these devices is due to the development of ferrite cores with very-low-temperature coefficients. Inductor performance is determined almost entirely by the characteristics of the ferrite core on which the inductor is wound.

Semiconductors, such as transistors and diodes, are essentially commercial units which have been adapted to micro-element form.

There are presently four kinds of transistors, equivalent to types 2N109, 2N404, 2N140 and 2N384. Each transistor is hermetically sealed within the cavity of a specially recessed wafer.

There are three kinds of micro-element diodes (Fig. 6), equivalent to the 1N277, 1N643 and a Zener type. Each diode is assembled by soldering the commercial semiconductor directly to the wafer.

Micro-element crystals operate in the range of 7 to 70 mc. Three wafers are required to house each crystal. The quartz crystal is mounted in the

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center hole of a special kind of wafer, covered on each side by two conventional solid wafers, and then hermetically sealed.

To save space, two or three micro-elements are sometimes assembled on a single wafer. This also increases reliability, since the number of soldered connections is reduced. Such multiple types of micro-elements include R-C networks, L-C filters and other combinations.

Still to be developed are the micro-elements for thermistors, thyristers, magnetic devices, solid-state switches and variable circuit elements.

Kinds of micromodules

A complete micromodule consists of a number of micro-elements arranged so the combination constitutes a desired electronic circuit—oscillator, amplifier or other complete stage. Connecting leads usually pass through the notches in the wafer of each micro-element. Additional riser leads are used to dissipate heat generated within the micromodule during operation. A terminal wafer is placed over the end of the stack, internal connectors are soldered and the entire assembly is permanently encased (Fig. 7). Only leads for external connections protrude.

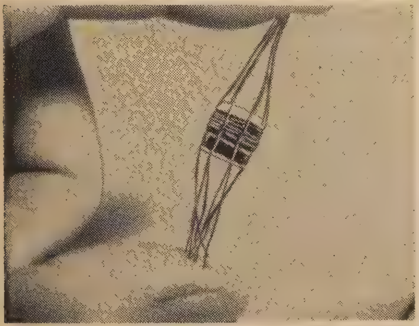

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Fig. 7—Complete, encased micromodule ready for use.

In operation, a micromodule is basically an integrated electronic stage that provides a specific, complete circuit function. For such operation, it requires a source of power and appropriate input, output and other connections.

To date, nearly 20 distinct kinds of micromodules have been developed, fabricated and used successfully as part of the military–industry program.

Representing a wide range of circuit functions, some of the principal kinds that demonstrate the potential capabilities of micromodules in rf, if, audio and digital circuitry are:

- An rf amplifier (Fig. 8) provides 10 db gain at 48 mc as the input stage of a portable military radio receiver. The micromodule includes a type 2N384 transistor, and a microminiature transformer with an rf ferrite core.
- For the same military receiver, an if amplifier (Fig. 9) has a gain of 20 db at a frequency of 4.3 mc with a bandwidth of about 200 kc. The stage includes a 2N384 transistor.

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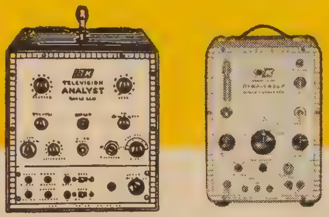

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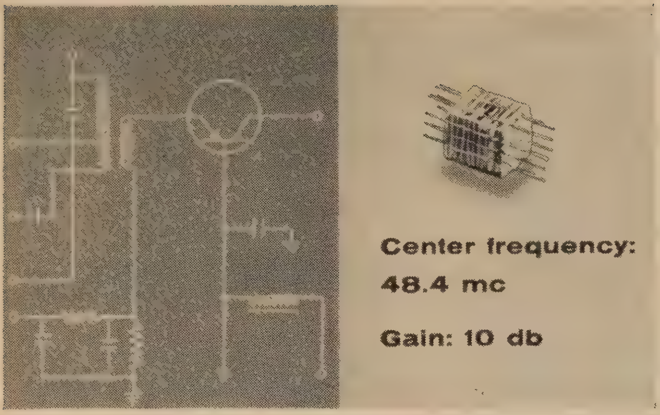


Fig. 8—Rf amplifier circuit and equivalent micromodule used in military radio receiver.

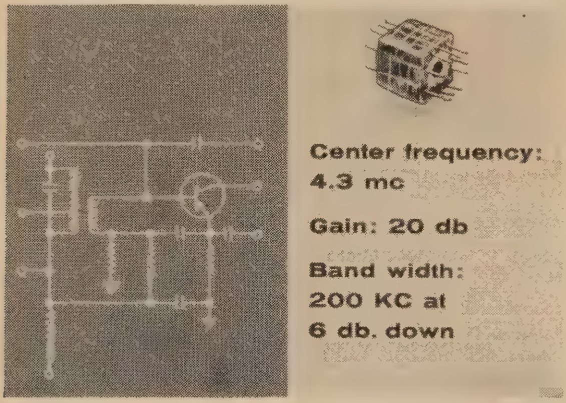


Fig. 9—If amplifier circuit and equivalent micromodule.

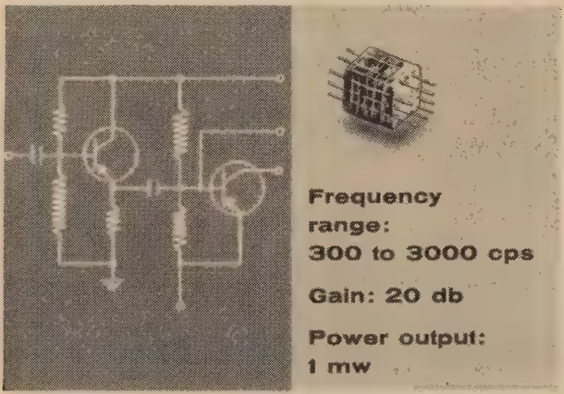
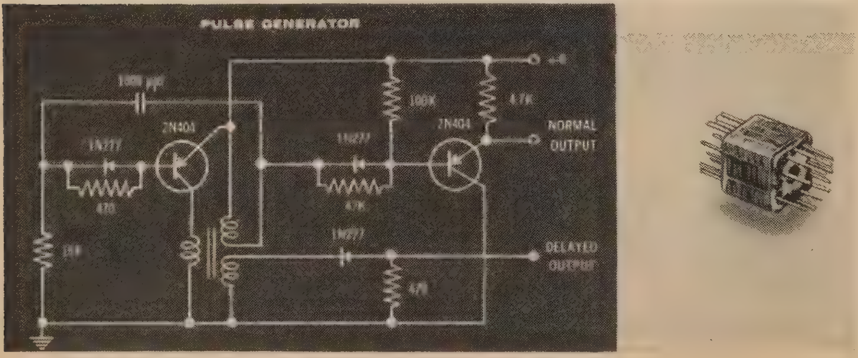


Fig. 10—Audio amplifier circuit and the micromodule it represents.

Fig. 11—Pulse generator as a micromodule.



▶ An audio amplifier (Fig. 10) for the same receiver has 20 db gain, with a frequency range from 300 to 3,000 cycles. The micromodule includes two 2N269 transistors, the first of which functions as an emitter follower in place of the usual audio input transformer.

▶ A variety of digital type microminiature devices have also been developed. These include binary dividers, gates, clippers, pulse generators, sawtooth generators, output amplifiers and others—each constructed in the form of a single micromodule.

▶ Typical of these is the pulse generator stage (Fig. 11), which includes two type 2N404 transistors, three type 1N277 diodes and a 1:1:1 microminiature pulse transformer.

Combining modules

When a number of appropriate micromodules are connected together, the complete circuitry for an electronics device can be provided in microminiaturized form.

For example, a seven-stage transistor superheterodyne radio receiver is so small it can be held in a spoon. This combination consists of seven interconnected micromodules that include an rf amplifier, if amplifiers and an audio amplifier. The only additional parts needed to put the unit into operation are an antenna, a source of power and some type of reproducing device.

Another assembly of micromodules built into a fountain-pen case, forms a five-stage transistor radio receiver. The case also contains an antenna, tuning controls and a small battery. In strong signal areas, it receives local reception broadcast-band stations excellently.

Future applications of the micromodular concept are almost unlimited, particularly where critical size and weight limitations affect the design of communications and electronics equipment. Even though some systems—such as certain types of automatic data-processing equipment—become increasingly complex, micromodules will help minimize size and weight and will simplify repair and maintenance.

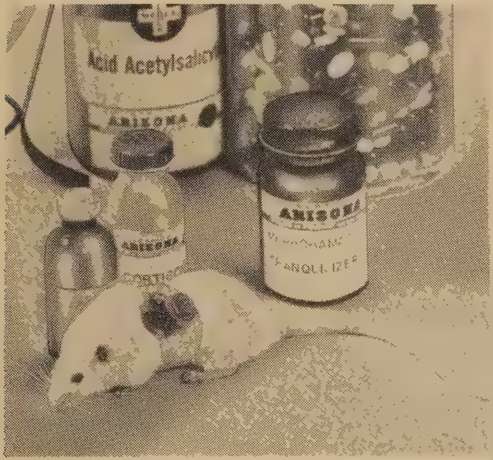
Much further research, design and development are necessary—not only to improve initial accomplishments but also to extend the micromodular concept into new areas.

One of these areas is semiconductors. There'll be more extensive use of semiconductors as the active circuit elements of micromodules, because the vast majority of existing electronics circuits can be transistorized.

Virtually all future equipment operating at low or medium power levels will use transistors and other semiconductor devices. At the same time, advances in solid-state physics can be used directly in developing new types of micromodules. Thus, the micromodular idea becomes the logical stepping stone to multi-function solid-state devices of the future. END

MOUSE transmits own temperature

Weighing less than 3.5 grams, this little transmitter reads the temperature of laboratory animals without disturbing them



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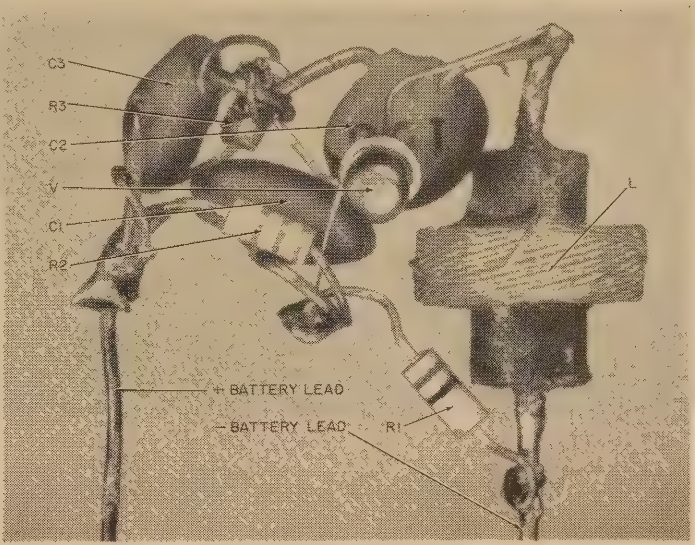
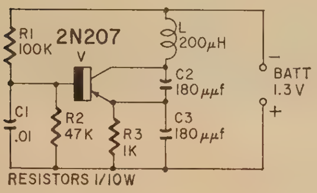


Closeup view of the subminiature transmitter.



Circuit of the 1-transistor transmitter.

"ARE you man or mouse?" This time the radio transmitter is operated by a mouse. Yes, our white mice transmit and so do our rabbits.

The College of Pharmacy at the University of Arizona needed a device that would give a constant indication of body-temperature changes of laboratory animals. These readings would be recorded while the effect of various drugs on the animals was being tested.

The final results of the drug tests were important, but knowing what was happening to body temperature all through the testing was just as vital. Body temperature of animals (including man) is a great controlling factor in their life functions.

Normally, a rectal thermometer is used to measure the temperature of laboratory animals. But there is a catch to this method—when an animal is handled in any manner, its temperature goes up almost immediately. So even though the thermometer may be a highly accurate instrument, readings are not necessarily true indications.

The College of Pharmacy needed an instrument which would indicate body-temperature changes without disturbing the animal. It would have to give a continuous reading so rate of temperature change as well as the relative amount of change could be seen. If it could be calibrated to show the actual temperature too, the instrument would be doubly valuable.

R1—100,000 ohms, 1/10 watt
R2—47,000 ohms, 1/10 watt
R3—1,000 ohms, 1/10 watt
C1—.01 μf, ceramic
C2, 3—180 μμf, ceramic
BATT—mercury cell, 1.3 volts (Eveready E400 or equivalent)
L—200 μh, peaking coil (Miller 6154 or equivalent)
V—2N207

Size and weight were important. After all, a 15-gram white mouse couldn't be expected to carry around a load equal to its own weight. Transistors and other miniature parts were vital, and this meant a subminiature power source as well.

First attempts

On this basis, the work started, Read C. Easton (W1NAO/7) and myself being handed the job by Richard F. Childs of the college faculty.

It was obvious that the transmitted signal would be extremely low power. But what signal would be used? An oscillator was tried first. A thermistor varied its frequency in proportion to temperature changes. Such a unit seemed to give favorable results, but we had to get a rather large mouse to carry the load. Transmitter weight was about 18 grams, and the animal could barely straighten his hind legs.

Next, a much smaller thermistor was used. And the entire unit was powered by a section sliced off a penlight cell. A few tests revealed that the thermistor was unnecessary—a small resistor (R2) could be substituted. The oscillator was very sensitive to heat variations, causing the desired frequency variations without a thermistor. (See diagram for a look at the circuit.) It operates on 750 kc at 25°C. The oscillator was encapsulated in plastic.

The first real test was made on a rabbit, in a laboratory class supervised by Dr. Albert L. Picchioni. The animal had been given a drug that would raise its body temperature.

A random length of wire coiled loosely

(*Continued on page* 106)

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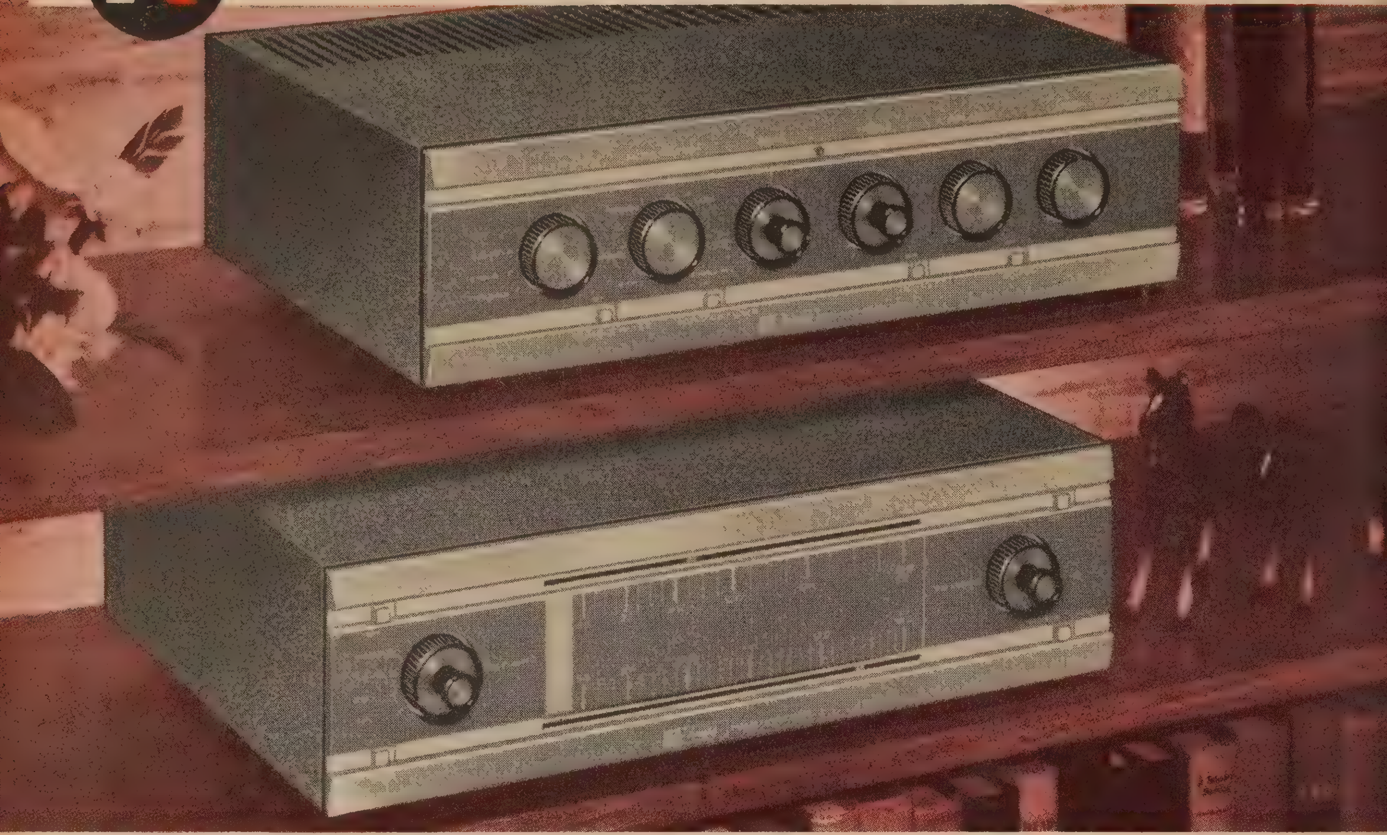

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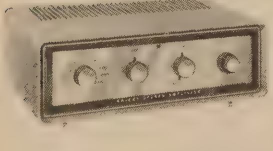

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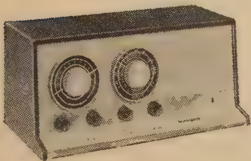

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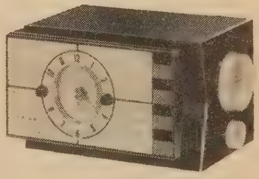

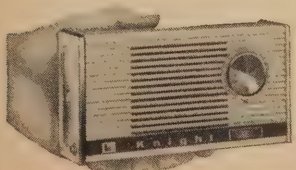

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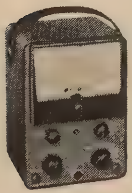

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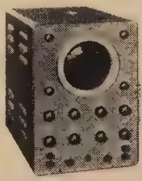

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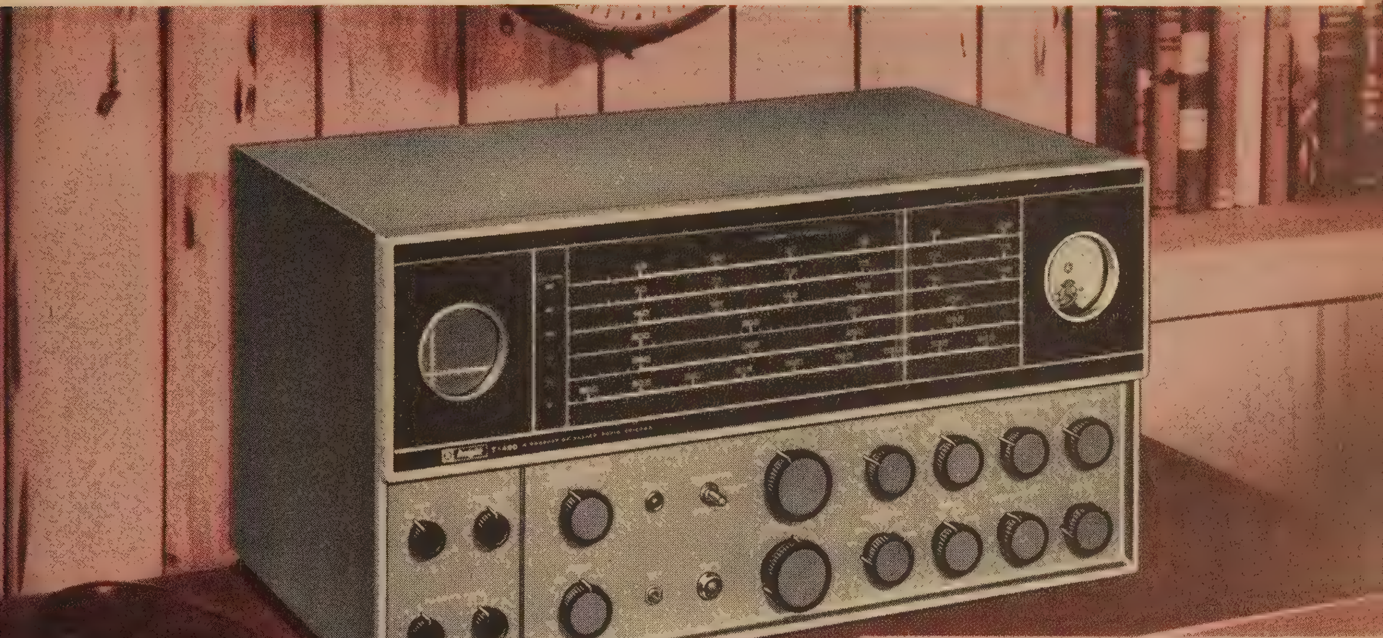

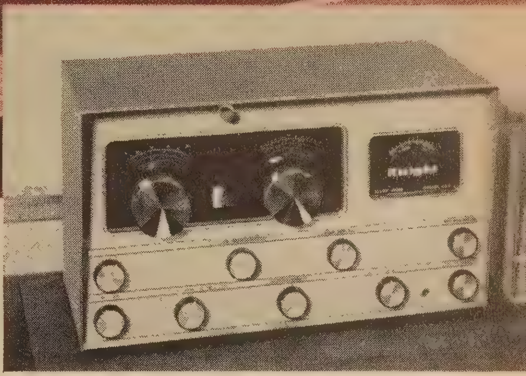

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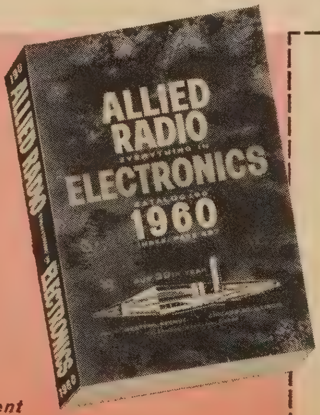

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(*Continued from page 101*)

on the table formed the receiving antenna. A piece of plastic about 3 feet square was placed over it and the animal rested on the plastic sheet. The transmitter was attached to the rabbit's belly with adhesive tape (the hair was clipped from that area).

A short antenna from a BC-221 frequency meter was coupled loosely to the receiving antenna, and frequency recordings were made every 2 minutes.

After testing had continued for about 15 minutes, the animal's temperature was taken with a rectal thermometer. Then the rabbit was given a drug which lowered its body temperature rather slowly. Frequency readings every 2 minutes were continued, and temperatures were recorded with the thermometer every ½ hour. The entire test took 3 hours.

Results were most encouraging. They showed definitely that every time the animal was excited by being handled its temperature went up and after handling promptly dropped back and continued to decrease. It showed the rate and amount of temperature decrease, and the effects of excitement.

Make it smaller

The transmitter was still too large for the average white mouse. So while university researchers continued their tests with the first transmitter, which was dubbed "Mousenik I," work began on a smaller unit. Resistors of 1/10 watt had been used, and the ceramic capacitors and coil were about as tiny as we could find. It became a matter of using the shortest possible leads, careful soldering, a tiny mercury battery, and only enough plastic to hold the unit together.

"Mousenik II" was completed and tipped the scales at 6 grams, complete with plastic and battery. It was only one-third the weight of the first unit. But with more clipping and use of clear Krylon in place of the plastic (several coats were sprayed on), "Mousenik III" was completed and weighed in at 3.3 grams, with battery!

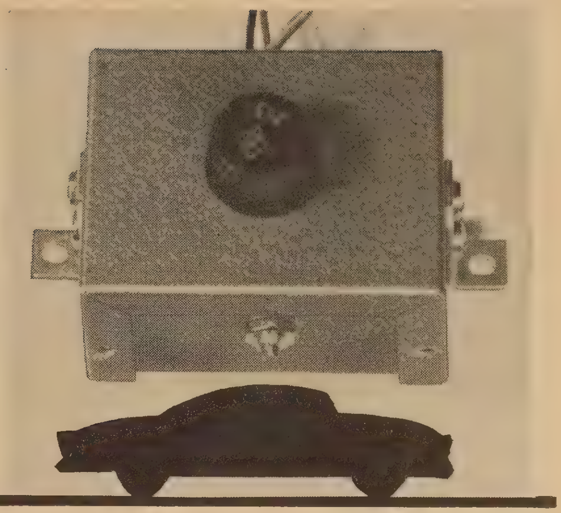
Now the white mice are about to have a new role in life. The present tiny unit does not even seem to be an inconvenience to the transmitting mouse.

The unit has a range of about 1 foot without any antenna. With an antenna, and a carbon microphone in series with a 3-volt battery to the coil, the unit was voice-modulated and a readable signal received at about 40 or 50 feet.

No attempt has been made to measure the unit's power output. The input is 0.3 ma at 1.3 volts, which means of course that the mercury battery will not need frequent replacement.

The white mice, rabbits and guinea pigs in the University of Arizona laboratories can now broadcast to all who will listen, and can give a message of vital importance to researchers. All of which means that medical research will profit indirectly by amateur radio—hams have again served. END

ALL-TRANSISTOR VOLTAGE REGULATOR FOR YOUR CAR



By **DANIEL MEYER***

Four-transistor circuit replaces the tricky vibrating contact in your car's voltage regulator

IF the battery in your car has ever boiled over and run dry, or slowly lost its charge, I am sure that you realize the importance of your generator's voltage regulator. This device keeps the generator's output voltage constant under all load and speed conditions encountered during normal driving.

A dc generator's output is usually regulated by controlling the amount of current flowing in the field winding. More field current increases the intensity of the magnetic field in the pole pieces. The armature cuts more lines of magnetic flux per revolution, and the output voltage goes up. This is all true if the speed of rotation is constant. Below a certain speed the generator does not deliver more than a few volts no matter how much field current flows in the field windings. At higher speeds less field current is needed to produce the same output voltage because the armature cuts the lines of flux faster.

Desirable characteristics for a regulator are:

- Good regulation under all load and speed conditions
- No radio interference
- Reliability and long service life
- Easy adjustment
- Low cost

Which quality is the most important depends on the application. Cars, small boats and most light aircraft use the vibrating-point type regulator. This regulator (Fig. 1) works reasonably well and is very cheap to produce. The relay coil is connected to the generator's output, and the normally closed contact points are in series with the field winding. The contact points and the relay's sensitivity are set so the points will open at the output voltage desired from the generator. This results in a very rapid opening and closing of the points as the voltage rises and falls about the operating points. The arc created at the points helps smooth the regulating action and cannot be suppressed with a capacitor if proper operation is expected.

This type of regulator is difficult to adjust and doesn't hold an adjustment too well. The arc at the points causes radio noise. This is especially objectionable on sensitive mobile radios used by hams. There is no way to change the setting on this regulator except by varying the point gap or relay armature tension.

A better regulator is the carbon-pile type. It is used in most military aircraft. Its construction is shown in Fig. 2. The amount of spring pressure on the stack of carbon discs controls the resistance of the stack. The stack is in series with the generator's field winding. Varying its resistance controls the field current and thus the output voltage, which is fed to a solenoid whose core is connected to the compression spring. Changes in the output voltage move the core and spring in or out, depending on whether the voltage goes up or down.

The regulating action of this type of regulator is smoother than the vibrating-point kind and it does not generate radio noise, but it does have moving parts that wear out. The carbon discs burn and pit with use and must be replaced periodically. The output voltage can be adjusted over a limited range with a potentiometer in series with the solenoid winding. Initial adjustments must be made by a trained person with special equipment. Incorrect adjustment can destroy the carbon discs, and make it necessary to replace the stack again. This regulator also costs much more than the simple point type.

All-transistor regulator

By using a power transistor as the resistance in series with the field (Fig. 3), most of the disadvantages of the previously discussed regulators are overcome. Basically the output voltage is sensed and compared with a reference voltage. The difference between the two is amplified and drives the transistor's base. Any change in the output voltage is instantly corrected for by a change in the transistor's emitter–collector resistance. Regulation is very close because of the high amplification of the transistor circuit. Output voltage can be adjusted after the regulator is installed. The reliability and service life of the unit are limited only by the quality of the transistors and components used. Heat drift of the transistor characteristics is no problem unless it is extreme. Drift in the reference diode could cause variations in output, but this is not likely in a properly designed circuit.

Let's see how the regulator works.

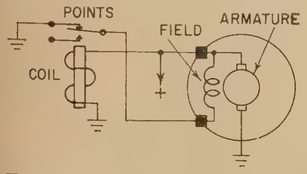


Fig. 1—This type voltage regulator is found in cars, small boats and most light aircraft.

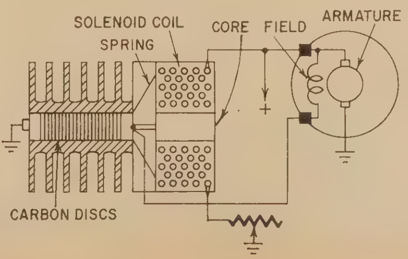


Fig. 2—The carbon-pile type regulator is used in most military aircraft.

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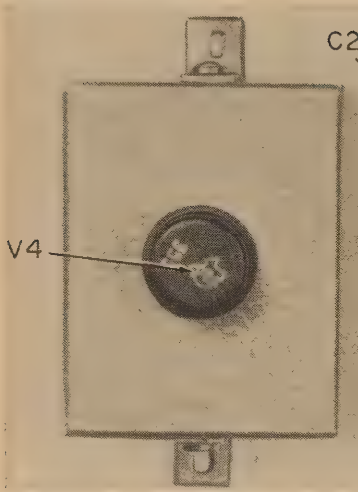
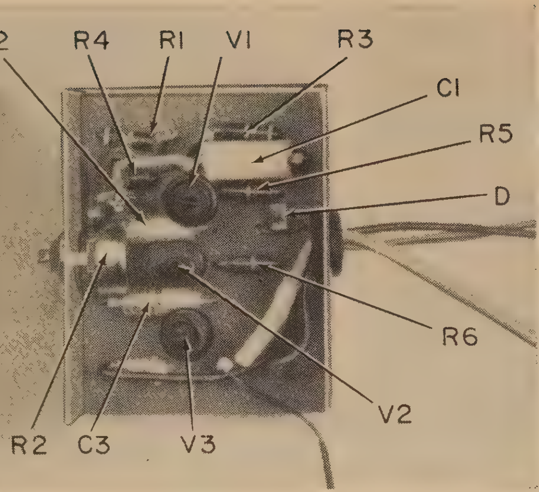
*Research engineer, Southwest Research Institute.

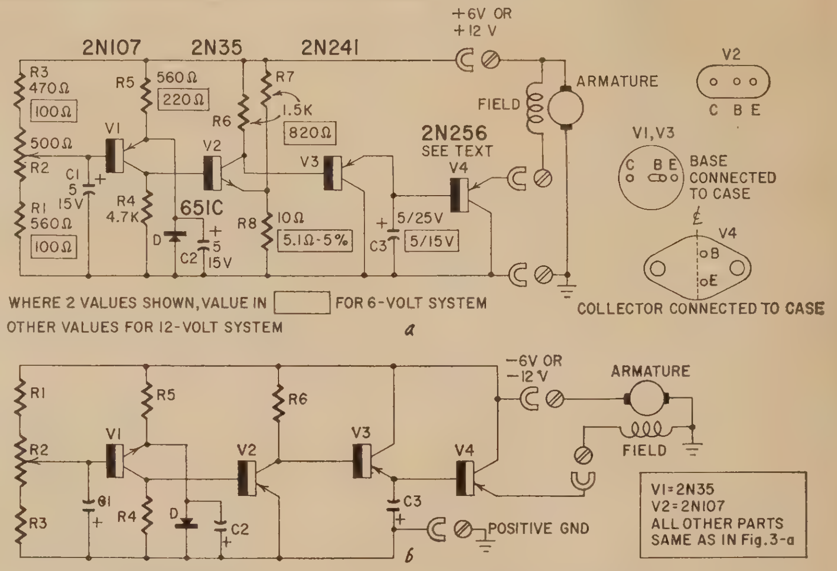


A few leads, a transistor and a potentiometer are the only components that extend outside the regulator case.


C2
R4
R1
V1
R3
C1
R5
D
R6
V2
R2
C3
V3

A few parts easily fit into the miniature case. Resistor R7 is not called out as it was added to the regulator circuit after the photographs were taken.

Fig. 3—All-transistor regulator does away with the moving parts in standard types: a—For a negative ground; b—For positive ground


+6V OR +12 V
2N107
2N35
2N241
R3 470Ω
100Ω
R5 560Ω
220Ω
R7
1.5K
820Ω
R6
V1
V2
V3
500Ω
R2
C1 5 15V
R1 560Ω
100Ω
R4 4.7K
651C
D
C2 5 15V
R8 10Ω
5.1Ω-5%
5/25V
C3
5/15V
FIELD
ARMATURE
2N256
SEE TEXT
V4
V2
C B E
V1,V3
C B E
BASE CONNECTED TO CASE
V4
B
E
WHERE 2 VALUES SHOWN, VALUE IN ☐ FOR 6-VOLT SYSTEM
OTHER VALUES FOR 12-VOLT SYSTEM
COLLECTOR CONNECTED TO CASE
a
−6V OR −12 V
ARMATURE
FIELD
R1
R5
R6
V1
V2
V3
V4
R2
R3
C1
R4
D
C2
C3
POSITIVE GND
V1=2N35
V2=2N107
ALL OTHER PARTS SAME AS IN Fig.3-a
b

R1—560 ohms
*100 ohms
R2—pot, 500 ohms
R3—470 ohms
*100 ohms
R4—4,700 ohms
R5—560 ohms
*220 ohms
R6—1,500 ohms
*820 ohms
R7—1,500 ohms
*820 ohms
R8—10 ohms
*5.1 ohms, 5%
All resistors ½-watt 10% unless noted

C1, 2—5 μf, 15 volts, electrolytic
C3—5 μf, 25 volts, electrolytic
*5 μf, 15 volts, electrolytic
D—reference diode (Texas Instruments 651C)
V1—2N107
*2N35
V2—2N35
*2N107
V3—2N241
V4—2N256 (see text)
Case, 2⅛ x 2¾ x 1⅝ inches
Miscellaneous hardware
*Indicates values to use for regulator for 6-volt systems.

The generator's output voltage is dropped across resistors R1, R3 and potentiometer R2. Transistor V1's base is connected to the arm on the potentiometer, and its voltage will vary with the output of the generator and the potentiometer setting. V1's emitter voltage is clamped at a predetermined level by reference diode D. This diode is similar in action to a voltage-regulator glow tube, but operates at a much lower level. It keeps V1's emitter at a constant voltage level while the base voltage is varying in proportion to the generator's output.

This produces a signal that is amplified by V1 and direct-coupled to V2's base. The signal is amplified by V2 and fed to V3's base. Transistor V3 is connected as an emitter follower. The circuit has some current gain, but its main purpose is to couple the high impedance of V2's collector circuit to the low impedance of V4's base circuit. A higher output voltage will make V1 conduct more current, raising V2's emitter-to-base voltage so V2 also passes more current in its collector circuit. This reduces V3's emitter-to-base voltage so less current flows in its collector circuit, and also in V4's base circuit. V4's emitter–collector resistance rises, reducing the field current, and output voltage returns to normal.

Lower output voltage does just the opposite and increases field current. Capacitors C1, C2 and C3 prevent hunting and any tendency to oscillate.

Other transistors can be substituted for the types specified as long as voltage or current ratings are not exceeded. The power transistor (V4) must have a reasonably high beta, since the operating voltage for its collector drops as more current flows in the field winding. If an inefficient transistor is used here, there might be difficulty in getting enough drive to produce full generator output under full-load conditions. (The author informs us that more suitable transistors have been developed since the article was written, and suggests that a 2N364 could well be used in the V2 position, and a Delco DS-501 used for V4.—*Editor*)

Before buiding the regulator you have to know which of the four variations of generator system circuitry is in your car. The generator field may be internally grounded, or it may be connected to the armature terminal. In addition there are both positive- and negative-ground systems.

To determine which system your car uses, connect an ammeter in series with the field circuit on the present regulator. Since the system's polarity can be determined by checking the connections at the battery you can find out which way the generator field is connected by observing which way the ammeter must be connected to read in the right direction.

For example, if the battery's positive terminal is connected to the engine block or chassis, and the ammeter reads up scale when its negative lead is connected to the generator and its positive lead to the regulator—the field is connected to the armature terminal. If the ammeter connections have to be reversed, the field is grounded internally.

The schematics shown (Figs. 3-a and 3-b) are for either negative ground, field connected to the armature, or positive ground, field-grounded generator circuits. If the system on the

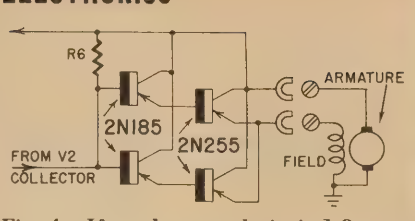


Fig. 4—If total power drain is 1.8 amps or higher use this output circuit for the regulator.

car is one of the other two types, the field connection inside the generator must be changed before this regulator can be used. **The power transistor's collector must be insulated from the case in the positive ground circuit.** This is done with a mica washer.

After the ammeter, used to check the field connections, is properly connected, leave it in the circuit and check the maximum field current. To do this start the engine and turn on all electrical units on the car—lights, heater blower, radio, etc. Now slowly speed up the engine and note the reading on the ammeter when a click is heard from the regulator box on the car. This is the reverse-current relay cutting in. If the reading is 1.8 amps or more, the dual-driver power transistor circuit shown in Fig. 4 must be used.

Construction kinks

The unit shown was built into a 2⅛ x 2¾ x 1⅝-inch case which also acts as a heat sink for the power transistor. All parts except the power transistor are mounted on a phenolic board in the model shown in the photographs. The small transistors were soldered directly in place to protect them against vibration. Sockets can be used if desired. Parts placement is not critical, and any convenient construction method will do just as well as the printed board used in my version. The connections to the emitter and base pins of the power transistor are made with single pins broken out of a miniature seven-pin tube socket. Put spaghetti over the pins to insure that no shorts develop when the box is assembled. All parts must be firmly in place since this unit will be subjected to rather violent motion at times.

When wiring the potentiometer, make sure that full counterclockwise rotation places the wiper tap closest to the positive line. This will give an increase in generator voltage when the potentiometer is turned clockwise on the completed unit. The photographs show a type 355 transistor in the power stage. This type is obsolete, but can be replaced by a 2N256. If a 355 is available or on hand it can be used on a 12-volt regulator, but would be worked too close to its maximum current ratings if it were used on a 6-volt unit. Any of the transistors listed in the parts list will work well on either 6- or 12-volt units.

(*Continued on page* 114)

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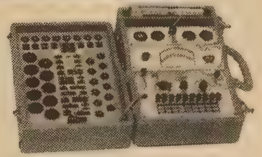

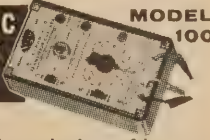
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This low-cost transistor checker safely tests PNP and NPN transistors either "in or out" of circuit. Covers wide range of types: small signal including "drift" types, medium power; and power types. Provides positive check for "opens," shorts, and gain—condition indicated by means of a visual indicator plus jacks for meter or scope. Also provides GO-NO-GO test at practical currents—and permits matching of similar types. Will not be obsoleted—no set-up or roll charts required! Compact, lightweight, complete, and ready-to-use.
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Plain Facts about ELECTRONICS and CREI

—why you need advanced electronics education

—how you can get it without quitting your present job

NO DOUBT you know what is happening in electronics. You know that the electronics industry is growing with extraordinary rapidity. You know that regardless of the ups and downs of the business cycle, openings are always found for men with solid, **advanced** electronics education.

You know that every computer needs installation and maintenance. You know that every missile carries the end result of years of electronics planning and development. You know that every piece of radar equipment, every servomechanism, every astronautical device, requires not only electronics designers and builders but also electronics maintenance personnel as well. You know that our new awareness of outer space is founded on the inner workings of satellites. Rockets make them possible and electronics guides them and makes them intelligible.

And you know that the day of the mediocre electronics man is done. Added responsibilities and salary increases go to men with both **theoretical** and **practical** knowledge.

CREI home study courses make you eligible for positions which require **advanced** electronics education. You need not quit your present job. You can meet your family responsibilities while gaining knowledge of electronics engineering technology so essential for career advancement.

CREI'S QUALIFICATIONS

We are now in our 34th year. 1958 marked the start of CREI Atomics, a division of CREI devised to meet the need for advanced home study education in nuclear engineering technology. 1958 also marked the opening of our European Division, bringing advanced professional electronic education to Western Europe.

Since 1927 we have directed the technical education of thousands—as individuals and in groups—in electronics engineering technology. We developed the first civilian pilot course for radio mechanics for the Army Signal Corps in 1941, supplied 300,000 texts to the U. S. Navy in a special course for radio technicians in the South Pacific in 1943, trained hundreds of technicians during World War II for the Signal Corps. We co-founded the National Council of Technical Schools, which first established scholastic and business standards for the technical school field. We were among the first three technical institutes whose curricula were accredited by the Engineers' Council for Professional Development. In 1946 we instituted the group training programs now used by companies which represent the cream of the electronics and aviation industries. In 1957 we initiated a plan which permits direct personal supervision for home study final exams.

What does this record of achievement mean to you as a CREI student?

It means that industry and the Armed Services alike respect CREI men. It means that your CREI diploma is a door opener.

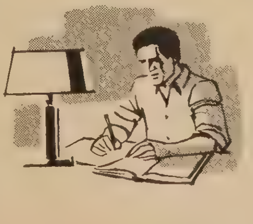
Significantly, Help Wanted ads often specify "CREI education or equivalent required." Our Placement Bureau, which helps graduates and advanced students find more desirable positions, is always available to CREI men. While no placement guarantees will be made by CREI or any other reputable institution, for many years the demand for CREI graduates and advanced students has far exceeded the supply.

Paul S. Lewis, Jr., a research assistant in an AEC-sponsored nuclear physics research program—and a CREI student — writes, "Like most large-scale physics projects, this machine (a proton accelerator) is largely electronics. The need for electronics technicians on basic scientific research projects will no doubt continue to grow."

Charles E. Lawson, another CREI student, brings out another point: "The fact that I am enrolled with CREI was met with enthusiasm on the part of my employer, Wright Airborne Electronics. A former student of CREI is now chief engineer for the company."

CREI HOME STUDY ADVANTAGES

Technical education is accomplished on your own time, during hours chosen by you. You waste no time in travel. You have plenty of time to do your best. Your work is under the supervision of a regular staff instructor who guides your progress step by step. Courses are prepared by experts, presented in easy-to-understand form, kept up to date by periodic revision. Experience in more than three decades of home-study teaching, during which time we have corrected and commented on many hundreds of thousands of examinations, enables us to avoid difficult-to-understand text matter in our lessons.



CREI STUDENTS

Our active home study roster today numbers more than 20,400 professional electronics engineers and technicians, all over the world and in every phase of electronics, about one-third military, the rest civilian. Their median age is 28. In 1958 they devoted approximately 1,572,465 hours to 104,831 lesson texts, answered (and were individually graded upon) 1,048,310 searching questions and engineering problems. They studied electronics engineering technology — transistors, microwaves, forward scatter, computers, servomechanisms, radar, electronic navigational devices, and the entire field of modern electronics. New students enrolled during the year are on the missile ranges of Vandenburg AF Base and Cape Canaveral. They are at Alamagordo and China Lake, at SAC bases around the world. They are in the research laboratories and manufacturing plants where the latest electronic equipment is designed and produced. They maintain electronic equipment for United Air Lines and Trans-Canada Air Lines. They share in electronics at All-America Cables and Radio, Inc., and The Martin Co. They work for U.S.I.A. (Voice of America) and Columbia Broadcasting System, for Gates Radio and Federal Electric, to name but a few. All of the firms mentioned offer their personnel CREI technical education under company plans. CREI men are found by the hundreds among field engineers of major electronic manufacturers. They're across the world —and across the street. They are the men you must compete with to hold your place in the electronics profession. Wouldn't you like to be as well qualified?

QUALIFICATIONS FOR CREI

College degree is not essential. If you have had basic electronic education, practical experience in electronics, and a high school education, you can probably qualify. A good way to find out: Use the postage-paid card. It will bring you the free book which has launched thousands on their advanced careers: "Insurance For Your Future in the New World of Electronics." Please fill out the card carefully, checking appropriate items and providing essential data. Tuition is reasonable and may be paid monthly. It takes just one $10-a-week raise to repay your investment in CREI education and leave you a substantial bonus the first year. Available to veterans under GI bill.

LATEST CREI COURSE

Automation and Industrial Electronics Engineering Technology. Complete course, covering all electronic phases of automation. Special emphasis on theory, functioning and applications of servomechanisms and computers. Also noteworthy—lessons on machine control, instrumentation, data processing and telemetry.

RESIDENCE SCHOOL

For those who can attend classes, CREI operates residence programs in Washington, D. C. Day and evening classes start at regular intervals. Qualified graduates earn AAS degree in 27 months. Electronics experience not required for admission.

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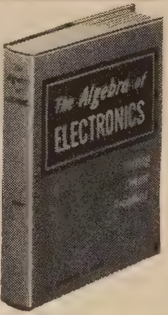

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Second, it's a handbook. Graphs and tables answer common electronic problems for those not wishing to work out complex derivations themselves.

Third, it's a review. Every equation is discussed, along with its practical on-the-job applications. 100 problems are shown with methods and answers provided.

THE ALGEBRA OF ELECTRONICS was written by Chester H. Page, Consultant to the Director of the National Bureau of Standards. Dr. Page discusses basic laws and fundamental principles, practical methods of solving simultaneous equations. He develops elementary Fourier waveform analysis, shows effects of frequency selectivity, modulation, and analyzes tubes, transistors and power supplies.

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ELECTRONICS

(*Continued from page* 109)

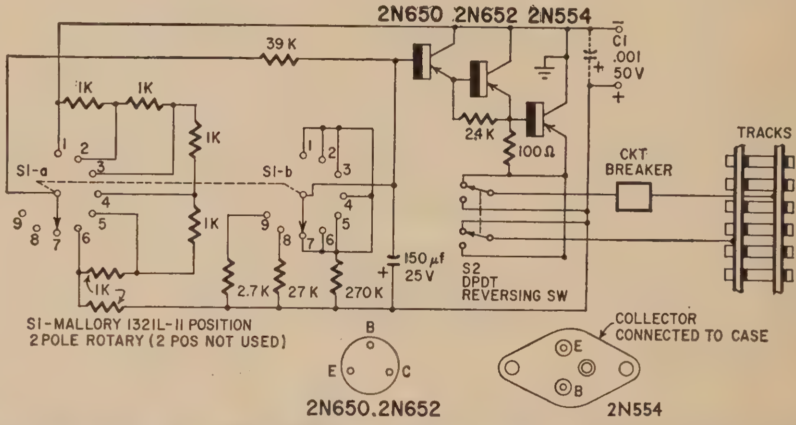
Installing the generator regulator on your car is easy. First remove the wire connected to the terminal marked FLD on the regulator in the car. Connect this wire to the wire coming from the emitter of the power transistor. Now connect the positive wire to the terminal marked ARM on the old regulator. Make sure the Minibox is grounded, or better yet, connect a wire from the ground on the circuit board to the case of the old regulator. *Note that the old regulator is not removed.* This is because the reverse-current relay and the current-regulator coil are also in the same box.

Setting the regulator requires a multimeter and a screwdriver. Connect the meter to the ARM terminal, and start the engine. Run the engine fast enough to get a steady reading on the meter. Now turn the potentiometer on the regulator until the desired output voltage is reached, and lock the adjustment. If a locking type potentiometer is not used, seal it with Glyptol or corona dope. The generator on a 6-volt system is usually set to 7.25 volts, and to 14.4 volts for a 12-volt system. END

MODEL TRAIN CONTROL

Very realistic starting, coasting and braking effects are obtained in a model train system by this automatic R-C time-delay control composed of the 150-μf capacitor and the various resistors. The voltage applied to the track changes smoothly between any of the switch positions. When entering "stop" position (7), the stop obtained is a realistic coasting stop. Faster braking is obtained in positions 8 and 9.

The power supply should be well filtered. However, you can get satisfactory results with unfiltered supplies by including capacitor C1. Values of R1, R2 and R3 can be changed to obtain different braking speeds. The 2N554 transistor should be fastened to the aluminum chassis for proper heat sinking.—*Motorola Semiconductors*



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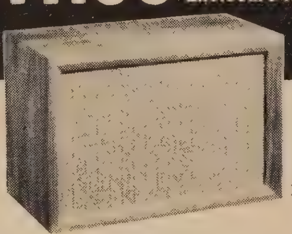
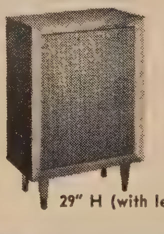


14" H
21" W
11¾" D
20 lbs.

Model One: Acoustically correct bass-reflex baffle for 12" or 8" speaker *at a come-and-get-it price.* Use it for a second speaker in your stereo system; for an extension speaker; for top sound reproduction from a first speaker. ¾" plywood with natural veneer finish on four sides eliminates unwanted resonance and provides an attractive appearance in horizontal or vertical use. Easily assembled. custom-designed to leave no end-plies visible.
Price: **11.90** in birch **15.90** in walnut

Complete finishing kit guaranteed to give a beautiful, durable luster to every kind of unfinished furniture. Contains two cans of varnish, sealer, brush, sandpaper, oil stain, and precise, easy-to-follow instructions. Available in Mahogany, Walnut, Blonde, Blonde Oak, Fruitwood, Maple, Cherry and Ebony. Specify when ordering. Price: **$3.98**



If the need is for something bigger try the Model Two. Its 4½ feet of baffle area gives you quality reproduction in combination with a 12" speaker. Brass-ferruled legs give it a clean, modern appearance. Meets the highest Homewood standards.

29" H (with legs), 20" W, 12½" D. 25 lbs.
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All you need to build is a Hammer-Screwdriver—and 30 minutes! That's how easy it is with a Homewood design.

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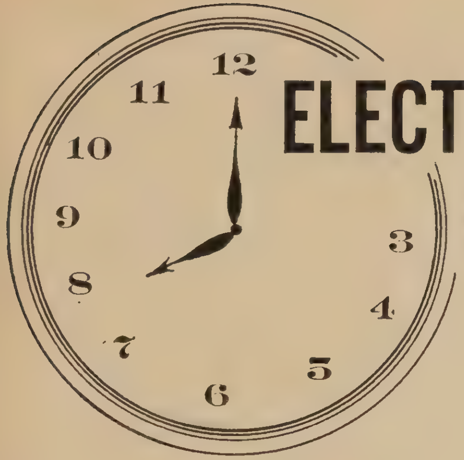
12
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ELECTRONIC ALARMS in CLOCK RADIOS

The buzzer is out. In both vacuum tube and transistor sets, audio oscillators are making that early morning awakening signal

By HENRY O. MAXWELL

THE new line of Westinghouse clock radios feature audio oscillators instead of the conventional buzzer type alarms. Fig. 1 shows the audio and alarm circuits of the V-2239-6 chassis used in the H-677T4 and similar models. When you wish to be awakened by the alarm instead of the radio, turn the set off with the ON—OFF—AUTO switch and turn the volume control fully counterclockwise. This opens S2-a and S2-b.

In the morning, when it's time to get up, the clock mechanism turns on the radio by connecting the B-minus bus and the heater-string return to one side of the ac line. Since S2-a is open, the plate of the 50C5 output tube is connected to the grid of the 12AV6 audio amplifier through C8 and C6.

Any minor disturbance in the 50C5 plate circuit is amplified by the 12AV6 and fed to the grid of the 50C5 in proper phase to sustain oscillations at around 800 cycles.

The NE-2A neon lamp is connected as an 8-cycle relaxation oscillator between the feedback line and ground. Each time the NE-2A fires, it short-circuits the feedback loop and keys the 800-cycle note on and off at an 8-cycle rate. The keying or interruption rate is determined by the values of R4, C7 and R5. Resistor R6 reduces the amplitude of the alarm signal to a comfortable level. The alarm is turned off and the radio on by advancing the volume control. This closes S2-a to short out R6 and S2-b to ground the feedback line.

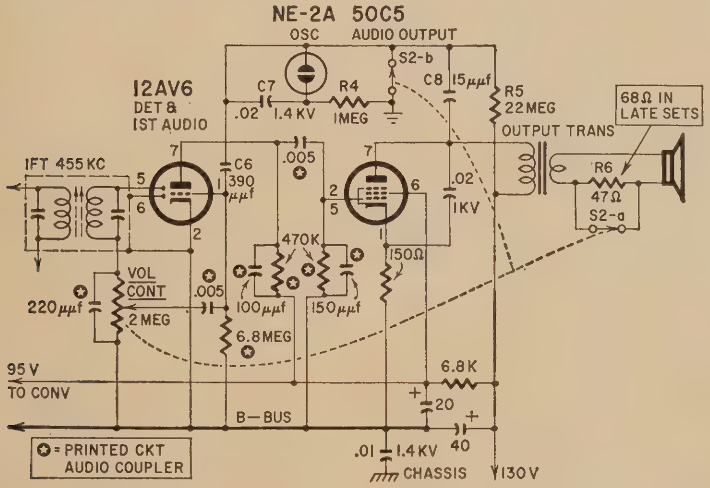

NE-2A
50C5
OSC
AUDIO OUTPUT
S2-b
C8
15μμf
R5
22 MEG
12AV6
DET &
1ST AUDIO
C7
.02
1.4 KV
R4
1MEG
68Ω IN
LATE SETS
OUTPUT TRANS
IFT 455 KC
7
5
6
2
1
C6
390
μμf
.005
2
5
6
7
1
.02
1KV
R6
47Ω
S2-a
470K
150Ω
VOL
CONT
220μμf
.005
2 MEG
100μμf
150μμf
6.8MEG
95 V
TO CONV
6.8K
20
B—BUS
40
= PRINTED CKT AUDIO COUPLER
.01
1.4KV
CHASSIS
130 V

Fig. 1—Audio and alarm circuits of the Westinghouse V-2239-6 chassis.

Transistor version

Fig. 2 shows the audio and alarm circuits of the Westinghouse Chantecler 8-transistor battery-operated model H-685P8 clock radios using the V-2396-1 chassis. When the volume control is turned to the extreme left, S1-a and S1-b open and the audio section of the receiver now functions as a 250-cycle oscillator. When S1-a is open, an in-phase signal is fed from one side of the push-pull output transformer through R27 to the base of the driver transistor to sustain oscillations. S1-b inserts R23 in the collector supply lead to the driver transistor. This reduces the collector voltage and drops the alarm volume to a pleasing level.

Advancing the volume control closes S1. S1-a grounds the feedback loop to kill the oscillations and S1-b shorts out R27 to restore normal collector voltage to the driver. END

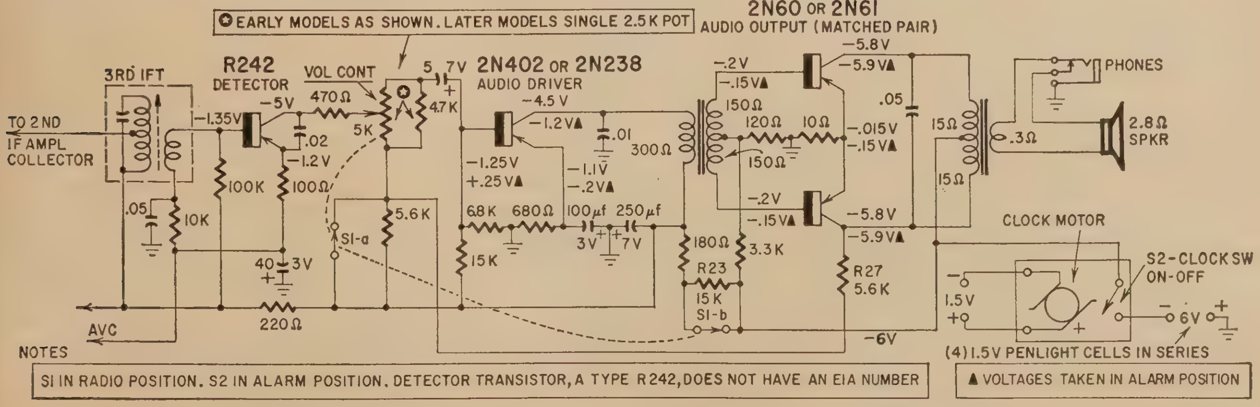
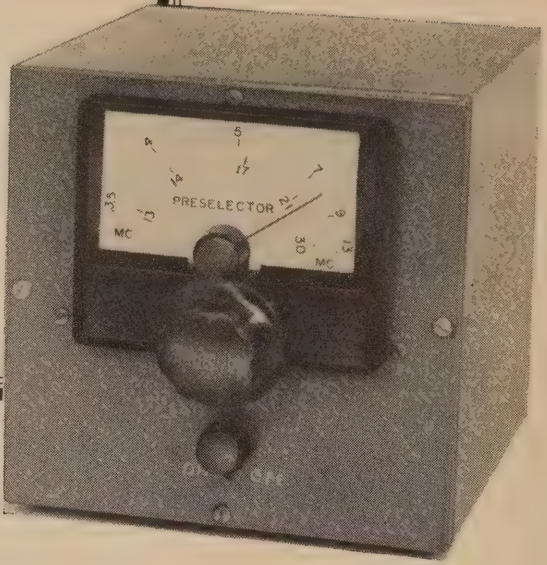

EARLY MODELS AS SHOWN. LATER MODELS SINGLE 2.5K POT
2N60 OR 2N61
AUDIO OUTPUT (MATCHED PAIR)
3RD IFT
R242
DETECTOR
VOL CONT
5
7V
2N402 OR 2N238
AUDIO DRIVER
TO 2ND
IF AMPL
COLLECTOR
−1.35V
−5V
470Ω
5K
4.7K
−4.5 V
−1.2V▲
.01
300Ω
.02
−1.2 V
100K
100Ω
.05
10K
40
3V
5.6K
S1-a
220Ω
AVC
−1.25V
+.25V▲
−1.1V
−.2V▲
6.8K
680Ω
100μf
250μf
3V
7V
15K
−.2V
−.15V▲
−5.8V
−5.9V▲
150Ω
120Ω
10Ω
−.015V
−.15V▲
150Ω
.05
15Ω
.3Ω
15Ω
PHONES
2.8Ω
SPKR
−.2V
−.15V▲
−5.8V
−5.9V▲
180Ω
3.3K
R23
15K
S1-b
R27
5.6K
−6V
CLOCK MOTOR
S2-CLOCK SW
ON-OFF
1.5V
6V
(4) 1.5V PENLIGHT CELLS IN SERIES
NOTES
S1 IN RADIO POSITION. S2 IN ALARM POSITION. DETECTOR TRANSISTOR, A TYPE R242, DOES NOT HAVE AN EIA NUMBER
▲ VOLTAGES TAKEN IN ALARM POSITION

Fig. 2—The setup in a transistor set, the Westinghouse model H-685P8.

No-Band-Switching PRESELECTOR


PRESELECTOR
3.5
4
5
7
9
13
14
17
21
30
MC
MC

Rf amplifier covers 3.5–30 mc without switching. Boosts receiver gain 6 to 9 S units

By ROBERT ABBATECOLA, W2YIZ

WANT a preselector to cover all frequencies from 3.5 to 30 mc without any band switching? It can be done by using one of the single-ended multi-band tuner circuits, employing the tapped-coil circuit. As shown in the schematic, the larger capacitance, C1-a and C11-a, of the dual capacitors is connected across the full coil and tunes from 3.5 to 13 mc. The smaller section, C1-b and C11-b, is connected to the tap on the coil and tunes from 13 to 30 mc. As you will note, at any particular capacitor setting there are two tuned frequencies. The section in use depends on the frequency to which the receiver is tuned. Therefore, all frequencies within the 3.5–30-mc range are amplified without any band switching.

The one switch on the preselector's panel does two things:

- In the off position, ac power is removed from the preselector and the antenna lead-in is connected to the receiver's input.
- In the on position, ac power is applied to the preselector, the antenna is connected to its input and the preselector's output is connected to the receiver's input.

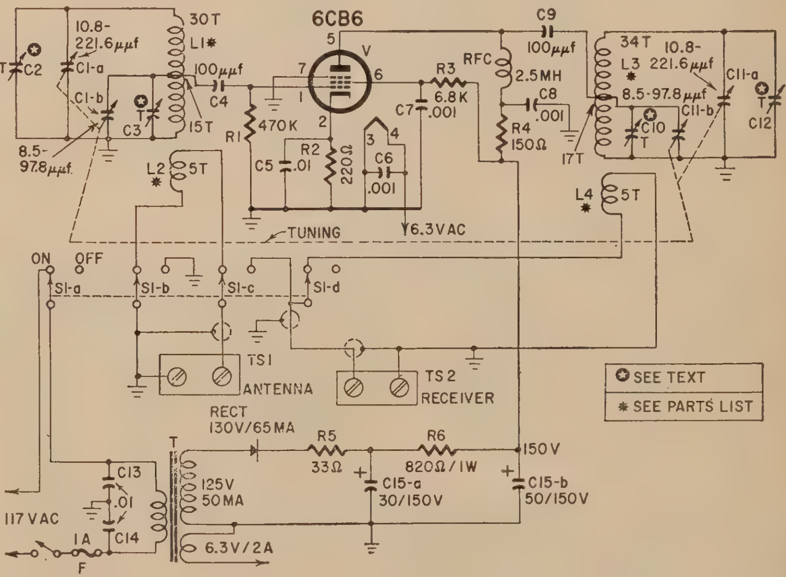
Running tests on my receiver at various amateur band frequencies, I got the following increase in S units:

mc	S-units
3.5	8
7.0	9
14.0	8
21.0	6
29.0	7

Consequently, with the preselector hooked up, there is a substantial increase in gain and signal-to-noise ratio, and the image frequency response is reduced at the higher frequencies.

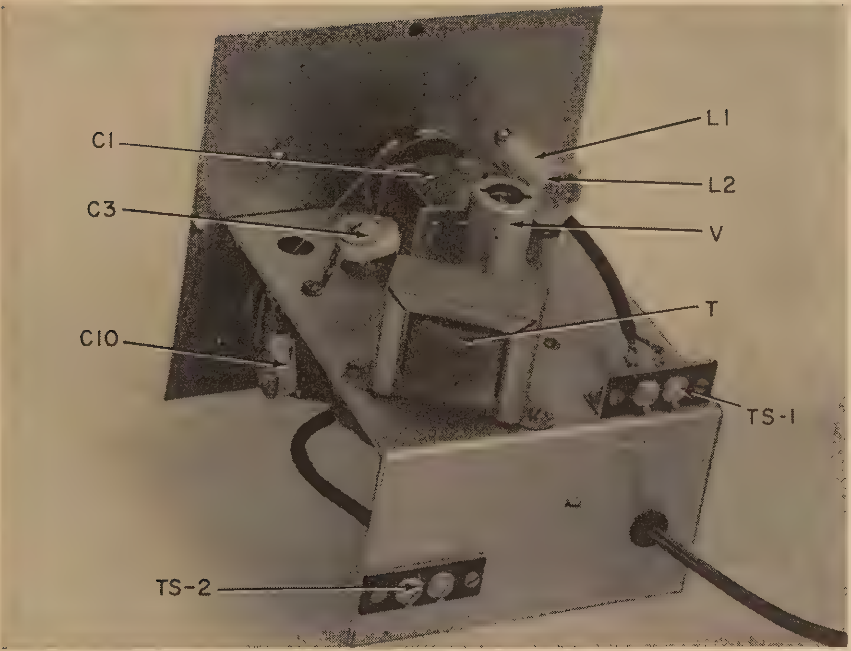
Mount the input coil and variable capacitors on the top of the chassis and the output coil and variable capacitors under the chassis. Also, install a small copper shield 1¾ inches high across the 6CB6 socket, connecting pin 3 and the socket's little round center shield to ground. Both steps are needed to shield the input signal from the output signal.

In putting a circuit of this type together, be careful when mounting and placing parts since both input (grid circuit) and output (plate circuit) are tuned to the same frequency. All component leads to the tube socket pins and ground should be as short as possible. Input circuit components must be kept as far from the output circuit as possible to prevent oscillation. And don't forget to use short lengths of coax cable


10.8-221.6µµf
30T
L1*
6CB6
C9
100µµf
34T
L3
10.8-221.6µµf
C11-a
T
C2
C1-a
C1-b
100µµf
C4
7
5
V
6
1
2
R3
6.8K
RFC
2.5MH
C8
.001
C7
.001
R1
470K
15T
C3
8.5-97.8µµf
L2
5T
R2
220Ω
C5
.01
3
4
C6
.001
R4
150Ω
17T
8.5-97.8µµf
C11-b
C10
C12
L4
5T
TUNING
6.3VAC
ON
OFF
S1-a
S1-b
S1-c
S1-d
TS1
ANTENNA
TS2
RECEIVER
SEE TEXT
SEE PARTS LIST
RECT
130V/65MA
R5
33Ω
R6
820Ω/1W
150V
C15-a
30/150V
C15-b
50/150V
T
C13
.01
C14
117VAC
1A
F
125V
50MA
6.3V/2A

R1—470,000 ohms
R2—220 ohms
R3—6,800 ohms
R4—150 ohms
R5—33 ohms
R6—820 ohms, 1 watt
All resistors ½-watt 10% unless noted
C1, 11—variable capacitors, dual section, 10.8 to 221.6 µµf and 8.5 to 97.8 µµf (Allied Radio No. 61 H011 or equivalent)
C2, 3, 10, 12—trimmers on C1 and C11 (see text)
C4, 9—100 µµf ceramic
C5, 13, 14—.01 µf, 600 volts, disc ceramic
C6, 7, 8—.001 µf, 600 volts, disc ceramic
C15—30-50 µf, 150 volts, electrolytic
F—1 amp
L1—30 turns Barker & Williamson, coil No. 3012 tapped at 15 turns from ground side
L2—5 turns No. 22 cotton-covered wound over ground end of L1
L3—34 turns Barker & Williamson coil No. 3012 tapped at 17 turns from ground side
L4—5 turns No. 22 cotton-covered wound over ground end of L3
RECT—130 volts, 65 ma, selenium
RFC—2.5 mh
S1—4-pole 2-position rotary, ceramic
T—power transformer: primary 117 volts; secondary, 125 volts, 50 ma; 6.3 volts, 2 amps (Stancor PS-8421 or equivalent)
TS1, 2—2-lug terminal strips
V—6CB6
Fuse holder
Socket, 7-pin miniature
Chassis to suit
Cabinet to suit
Miscellaneous hardware

Circuit of the 1-tube preselector.



Antenna and receiver terminals are on the back of the preselector's chassis.

between the antenna input to and the output from switch S1.

When making the tap on the Barker & Williamson No. 3012 coil, you will find it helpful to push the winding you intend to tap in toward the center of the coil and solder it by putting the iron through the top of the coil. This makes it easier to make the solder connection for the tap lead, which is covered with spaghetti, without getting solder on adjoining coil turns. The couplings or link coils are wound over the ground side of the main coils. One Barker & Williamson coil No. 3012 is turned into two main coils by cutting it in half.

A standard power supply is used. However, since the current requirements are very modest—6.3 volts ac at 0.3 amp and 150 volts dc at 10 ma—power could also be taken from the receiver to which the preselector is attached, provided it is a power transformer type.

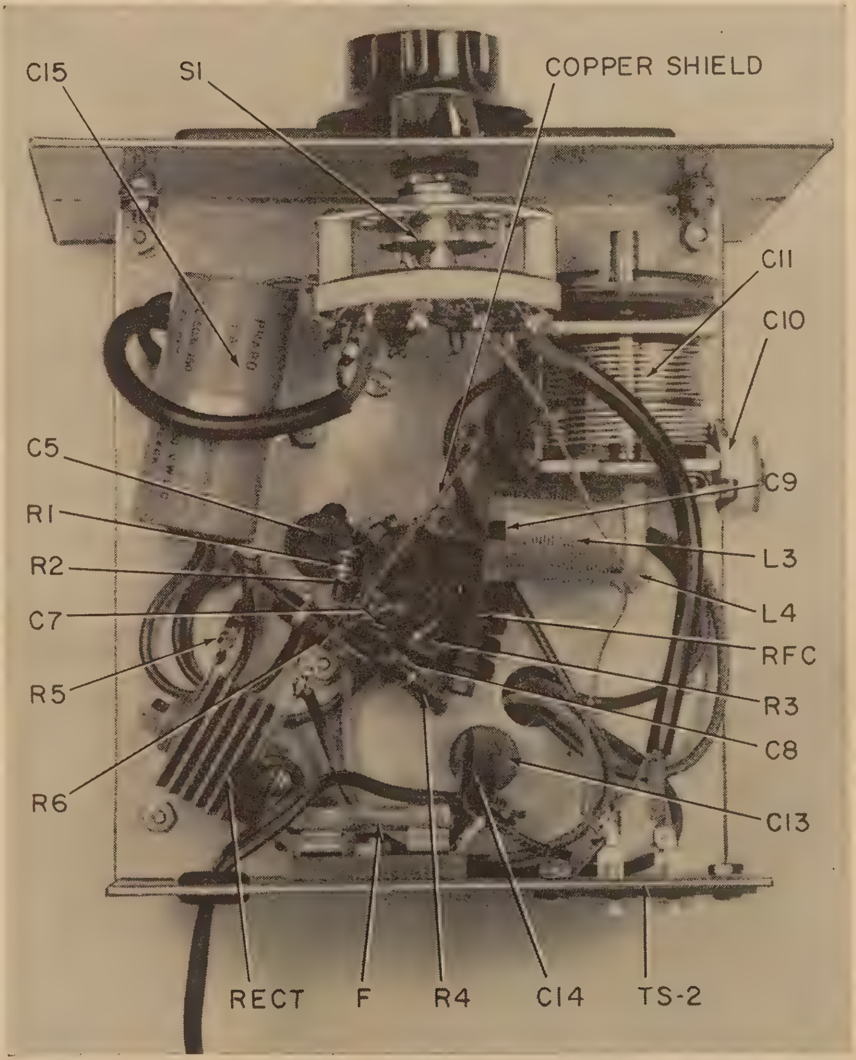
In the photographs, you can see just how the tuning capacitors are ganged. Two small dial drums (one on each shaft) are connected with a length of dial cord. A small spring is attached to one of the drums and the dial cable to keep the cable taut. A Millen vernier dial facilitates tuning. The cabinet is a 6 x 6 x 6-inch utility box.

Align before using

Alignment is comparatively simple. Connect a short length of coax cable from the preselector's output to the receiver's antenna input to help eliminate any tendency toward oscillation. Then, turn on the preselector. Feed a modulated 13-mc signal from a signal generator into the preselector's input and tune the receiver to the same frequency. Set the preselector so its variable capacitors are at minimum capacitance, fully opened position. Adjust trimmers C2 and C12 for maximum signal to the receiver, using the smallest input possible. Use the receiver's S meter as an indicator. If the receiver does not have one, connect an ac output meter to the speaker's voice coil and use it instead. With the preselector tuning capacitors left in the same position, switch the signal generator to 30 mc and tune the receiver to that frequency also. Then follow the same procedure you used on C2 and C12 for C3 and C10.

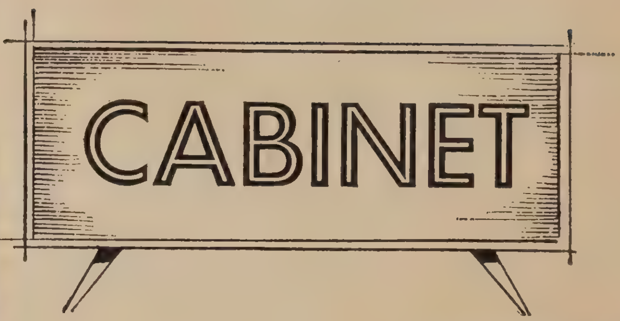
If a signal generator is not handy, use steady signals received at approximately 13 and 30 mc to align the preselector. In my unit the variable capacitors did not have trimmers, so I mounted 1.5–7-$\mu\mu$f ceramic trimmers across the variable capacitors.

To use the preselector, hook up the antenna (any kind will work), tune the receiver to the frequency desired and then the preselector until a maximum signal is indicated. END



Underchassis view showing a suggested parts layout.

RAPID CABINET REPAIR



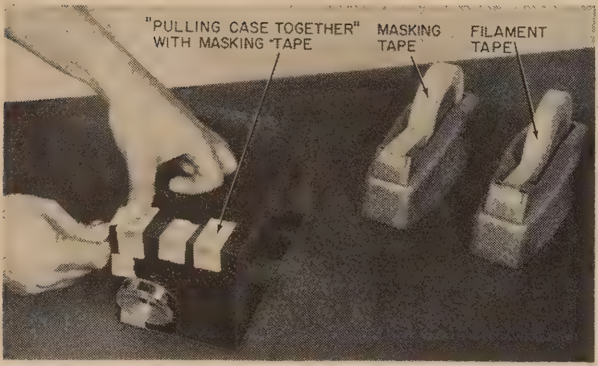

"PULLING CASE TOGETHER" WITH MASKING TAPE
MASKING TAPE
FILAMENT TAPE

Fig. 1—The first step is to fasten the pieces of the case together with masking tape or filament-reinforced tape.

20 minutes and some plastic resin rebuilds a broken radio or TV cabinet.

By EDWIN BOHR

NOT a week passes in an active repair shop without running into a customer with a cracked or broken TV or radio cabinet. And none of them wants to wait—sometimes several months—for a replacement cabinet.

If the job can be done quickly and without a patched-up look, the best solution is a cabinet repair. Plastic resins now available make such repairs attractive, easy, quick and profitable. The cost of material is negligible.

No special talents with woodworking, plastics or metals are required, and the resin works equally well on any of these materials. Just use reasonable care in mixing and applying them.

The completed cabinet repair will be almost invisible and the original cracks should be noticeable only on close inspection. The broken sections will bond to greater strength than the original cabinet.

Readers will be skeptical of these statements. We have all seen "cabinet repairs" smeared with speaker cement, plastered with adhesive tape, or melted and streaked from the action of powerful solvents. Give any of them a strong push and they fall apart.

The resins we are going to describe, are quite unlike any of the cements, adhesives or gunks used for electronic service applications. (Nearly all of these depend upon an evaporating solvent or vehicle.) They are liquid and remain liquid (even in an open container) until mixed with a hardener or catalyst. Mixed with the hardener, the resin gels and cures to a hard plastic within a matter of hours.

Because they are not glues, furniture clamps or great pressures are unnecessary while the resin solidifies.

They have high adhesive qualities, mechanical strength is good (compared with extremely poor for most service cements) and shrinkage is low. They adhere to both metals and nonmetals.

To make the resins even stronger, Fiberglas cloth, filaments or fluff may be added as reinforcement, producing a material stronger than steel in some respects.

Two classes of resin are readily available, the polyester and epoxy. The epoxy types have higher tensile strength, greater adhesion to metals and, in some instances, are easier

(*Continued on page* 122)

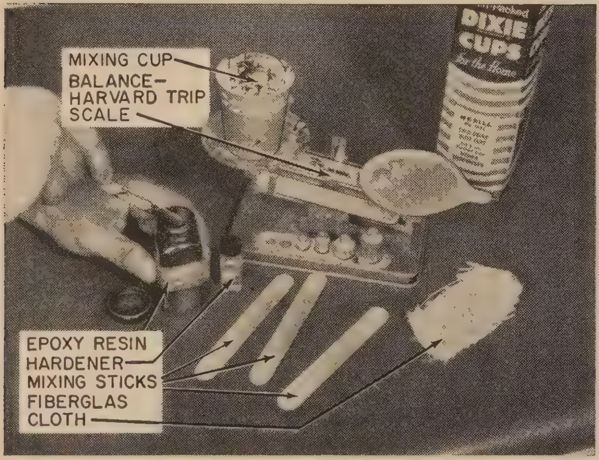
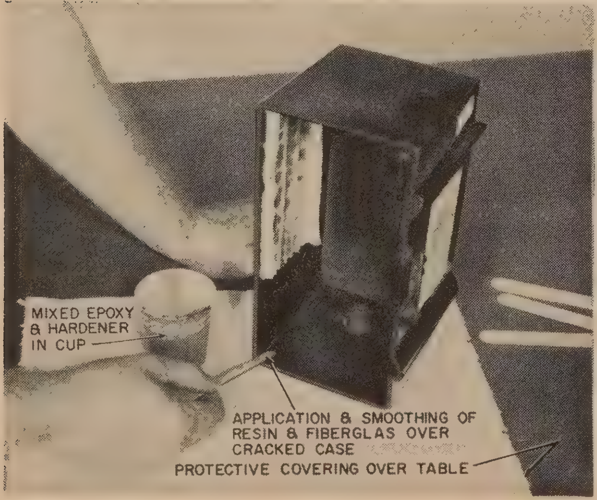

MIXING CUP
BALANCE—HARVARD TRIP SCALE
DIXIE CUPS
EPOXY RESIN
HARDENER
MIXING STICKS
FIBERGLAS CLOTH

Fig. 2—Equipment and materials for mixing the resin.

Fig. 3—All resin is applied to inside surfaces of the cabinet.


MIXED EPOXY & HARDENER IN CUP
APPLICATION & SMOOTHING OF RESIN & FIBERGLAS OVER CRACKED CASE
PROTECTIVE COVERING OVER TABLE

NUMBER 2 OF A SERIES
OF CD
30TH ANNIVERSARY PROMOTIONS!
SUB-MINIATURIZED
ALUMINUM-FOIL
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30%
SMALLER
30%
MORE RELIABLE

Cornell-Dubilier aims a 30-30 promotion at you for a big birthday bull's eye — and hits the mark with "Electomites"® — the sub-miniature, *metal-cased* electrolytic capacitors that are *30% smaller* and 30% more reliable than conventional electrolytics. Fabricated from selected highest-purity aluminum foil and unsurpassed in performance, "Electomite" tubulars also have a "short"-preventing plastic sleeve which makes them perfect for those close-fitting coupling, bypass and filter applications you come across every day in low-voltage, transistorized and printed circuitry.

HERE'S THE PROMOTION:

Quantity	Type No.	Capacitance (mfd.) Tolerance: —10%, +150%	Voltage
4	NLW 40-3	40	3
4	NLW 10-15	10	15
3	NLW 50-15	50	15
3	NLW 100-15	100	15

ALL 14 for $8.67

This 30-30 promotion is good for 60 days. So get the full story—*and the promotion*—from your Cornell-Dubilier Distributor today! Also ask about C-D's complete, special capacitor line for industrial electronic maintenance.

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AFFILIATED WITH FEDERAL PACIFIC ELECTRIC COMPANY

NOW YOU CAN HAVE YOUR CHOICE OF CENTURY'S UNIQUE Peak-to-Peak VACUUM TUBE VOLT METERS

Model VT-10
LINE OPERATED

WITH LARGE EASY-TO-READ 6" METER

Model VT-1
BATTERY OPERATED

NEW
CENTURY

featuring the sensational new *MULTI-PROBE* *(Patent Pending)*

No extra probes to buy! The versatile MULTI-PROBE does the work of 4 probes

① DC Probe ② AC-Ohms Probe ③ Lo-Cap Probe ④ RF Probe

No longer do you have to cart around a maze of entangled cables, lose time alternating cables or hunting for a misplaced probe. With just a twist of the MULTI-PROBE tip you can set it to function as either a DC Probe, AC-Ohms Probe, Lo-Cap Probe or RF Probe.

LINE OPERATED

Ideal for use on the test bench. Designed to run cool even under continuous operation . . . Line isolated.

BATTERY OPERATED

Completely portable . . . Invaluable wherever line connection is undesirable or unavailable . . . Unique circuitry assures low battery drain.

Model VT-10
$58.50 Net

TERMS: $14.50 within 10 days. Balance $11 monthly for 4 months.

FEATURES OF VT-1 and VT-10

- New advanced pentode amplifier circuit
- Large 6" 100-microampere meter, many times more sensitive than meters used in most V.T.V.M.s
- Simplified multi-color easy-to-read 4-scale meter
- No heat operation assures stability and accuracy
- Amplifier rectifier circuit with frequency compensated attenuator — a feature found only in costly laboratory instruments
- Meter completely isolated
- Hand-crafted circuitry eliminates the headaches of printed circuitry
- 1% resistors used for permanent accuracy
- Rugged gray hammertone steel case provides necessary shielding and eliminates plastic case drawbacks of cracking or melting
- Deep brushed long lasting etched aluminum panel
- Matching cover protects instrument face — snaps on and off instantly.

FUNCTIONS OF VT-1 and VT-10

DC VOLTMETER . . . Will measure D.C. down to 1.5 volts full scale with minimum circuit loading, and give accurate readings of scale divisions as low as .025 volts . . . Will measure low AGC and oscillator bias voltages from .1 volts or less up to 1500 volts with consistent laboratory accuracy on all ranges . . . Zero center provided for all balancing measurements such as discriminator, ratio detector alignment and hi-fi amplifier balancing.

AC VOLTMETER . . . True Peak-to-Peak measurements as low as 3 volts of any wave form including TV sync, deflection voltages, video pulses, distortion in hi-fi amplifiers, AGC and color TV gating pulses . . . Scale divisions are easily read down to .1 volts . . . Measures RMS at 1/20th the circuit loading of a V.O.M. . . . Unlike most other V.T.V.M.'s there is no loss in accuracy on the lowest AC range.

ELECTRONIC OHMETER . . . Measures from 0 to 1000 megohms . . . Scale divisions are easily read down to .2 ohms . . . Will measure resistance values from .2 ohms to one billion ohms . . . Will detect high resistance leakage in electrolytic and by-pass condensers.

RF and LO-CAP MEASUREMENTS . . . With these extra VT-1 functions you can measure voltages in extremely high-impedance circuits such as sync and AGC pulses, driving saw tooth voltages, color TV gating pulses, mixer output levels, I.F. stage-by-stage gain and detector inputs.

Model VT-1
$58.50 Net

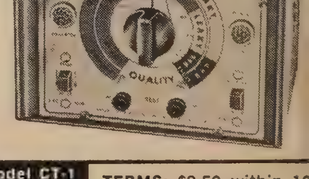
TERMS: $14.50 within 1
days. Balance $1
monthly for 4 months.

SPECIFICATIONS OF VT-1 and VT-1

- **DC Volts** — 0 to 1.5/6/30/150/300/600
1500 volts
- **AC Volts (RMS and Peak-to-Peak)** — 0 t
3/12/60/300/1200 volts
- **Ohms** — to a billion ohms, 10 ohms center scale — RX1/10/100/1K/10K/100K/
1M
- **RF** — Peak reading demodulator supplied for use on all DC ranges
- **Zero Center** — available on all DC vol
ranges with zero at mid-scale
- **Decibles** — from —10 Db to +10/22
36/50/62 based on the Dbm unit: ODb
IMW in 600 ohms
- **Impedance** — 11 megohms DC, 1 megohm AC, 10 megohms Lo-Cap
- **Input Capacity** — 130 mmfd. RMS, 25
mmfd. Peak-to-Peak, 25 mmfd. Lo-Cap

Model CT-1 IN-CIRCUIT CONDENSER TESTER

Here is an **IN-CIRCUIT CONDENSER** that **DOES THE WHOLE JOB!** The CT-1 actually steps in and takes over where all other in-circuit condensers fail. The ingenious application of a dual bridge principle gives the CT-1 a tremendous range of operation . . . and makes it an absolute 'must' for every serviceman.



in-circuit checks:

- ✓ Quality of condensers even with circuit shunt resistance . . . (This includes leakage, shorts, opens, intermittents)
- ✓ Value of all condensers from 200 mmfd. to .5 mfd.
- ✓ Quality of all electrolytic condensers (the ability to hold a charge)
- ✓ Transformer, socket and wiring leakage capacity

out-of-circuit checks:

- ✓ Quality of condensers . . . (This includes leakage, shorts, opens and intermittents)
- ✓ Value of all condensers from 50 mmfd. to .5 mfd.
- ✓ Quality of all electrolytic condensers (the ability to hold a charge)
- ✓ High resistance leakage up to 300 megohms
- ✓ New or unknown condensers . . . transformer, socket, component and wiring leakage capacity

OUTSTANDING FEATURES

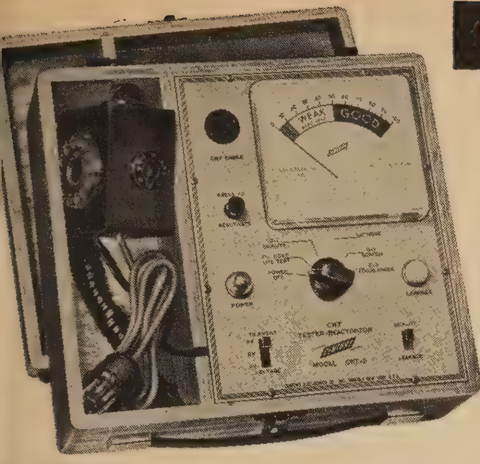
- Ultra-sensitive 2 tube drift-free circuitry
- Multi-color direct scale readings for both quality and value . . . in-circuit or out-of-circuit
- Simultaneous readings of circuit capacity and circuit resistance
- Built-in hi-leakage indicator sensitive to over 300 megohms
- Cannot damage circuit components
- Electronic eye balance indicator for even greater accuracy
- Isolated power line
- Deep brushed long lasting etched aluminum panel
- Housed in sturdy gray hammertone finish steel case . . . comes complete with test leads

Model CT-1
$34.50 Net

TERMS: $9.50 within 10 days. Balance $5 monthly for 5 months.

10 DAY *FREE* TRIAL ON CENTURY INSTRUMENTS OF YOUR CHOICE

See for yourself at no risk why thousands of servicemen all over the country selected CENTURY test equipment above all others. Send for instruments of your choice without obligation . . . try them for 10 days before you buy . . . only then, if satisfied, pay in easy-to-buy monthly installments — without any financing or carrying charges added.



Model CRT-2 CRT TESTER-REACTIVATOR

TESTS, REPAIRS and REACTIVATES

- *ALL BLACK AND WHITE PICTURE TUBES (including 110° tubes)* . . . from 8″ to 30″, whether 12 pin base, 8 pin base, 14 pin base . . . and the very latest 7 pin base.
- *ALL COLOR PICTURE TUBES* . . . Each of the red, green and blue color guns is handled separately.

CHECK THESE EXCLUSIVE FEATURES

- ✓ **THE MULTI-HEAD** (Patent Pending) . . . **A SINGLE PLUG IN CABLE AND UNIQUE TEST HEAD** —A tremendous advance over the maze of cables and adapters generally found with other testers.
- ✓ **WATCH IT REACTIVATE THE PICTURE TUBE** — You actually see and control the reactivation directly on the meter as it takes place. This allows you for the first time to properly control the reactivation voltage and eliminates the danger of stripping the cathode of the oxide coating. It also enables you to see whether the build-up is lasting.
- ✓ **CONTROLLED "SHOT" WITH HIGHER VOLTAGE FOR BETTER REACTIVATION** — Stronger than any found in other testers — high enough to really do the job — yet controlled to avoid damage to the picture tube.
- ✓ **UNIQUE HIGH VOLTAGE PULSE CIRCUIT** — Will burn out inter-element shorts and weld open circuits with complete safety to the picture tube.

Housed in
hand-rubbed
oak carrying
case — complete with
MULTI-HEAD

Model CRT-2
$57.50 Net

TERMS: $13.50 within 10 days. Balance $11 monthly for 4 months.

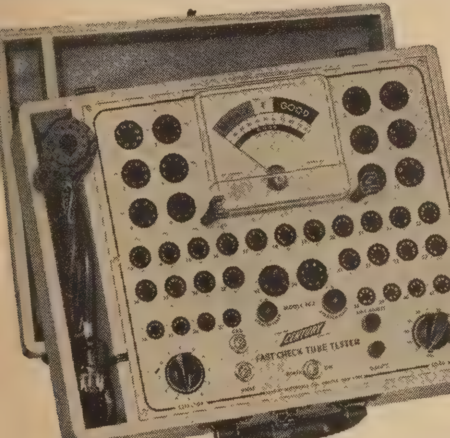
HE CRT-2 DOES ALL THIS RIGHT IN THE CARTON, OUT OF THE CARTON OR IN THE SET

TEST
- For quality of every black and white and color picture tube, employing the time proven dynamic cathode emission test principle.
- For inter-element shorts and leakage up to one megohm. Separate short test provided for each element in the picture tube.
- For life expectancy.

REPAIR
- Will clear inter-element shorts and leakage.
- Will weld open elements.

REACTIVATE
- The "SHOT" (high voltage controlled pulse) method of reactivation provided by the CRT-2 will restore picture tube to new life in instances where it was not possible before. The high voltage is applied without danger of stripping the cathode as you always have perfect control of the high voltage pulse.
- The '"BOOST" method of reactivation also provided by the CRT-2 is used effectively on tubes with a superficially good picture but with poor emission and short life expectancy. It will also improve definition, contrast and focus greatly and add longer life to the picture tube.

- ✓ **VISUAL LIFE TEST** — Enables both you and your customer to see the life-expectancy of any picture tube right on the meter . . . helps eliminate resistance to picture tube replacement when necessary.
- ✓ **SPECIAL LOW SCREEN VOLTAGE TUBES** — Will handle new type picture tubes with special low voltage of approximately 50 volts.
- ✓ **SEPARATE FILAMENT VOLTAGES** — including the very latest 2.35 volt and 8.4 volt types as well as the older 6.3 volt types.
- ✓ **NEW 'SF' PICTURE TUBES** — Accommodates the different base pin connections of this new type picture tube.



Model FC-2 FAST-CHECK TUBE TESTER

Simply set two controls . . . insert tube . . . and press quality button to test any of over 900 tube types completely, accurately . . . IN JUST SECONDS!

The FAST-CHECK enables you to cut servicing time way down, eliminate unprofitable call-backs and increase your dollar earnings by selling more tubes with very little effort on your part. You make every call pay extra dividends by merely showing your customer the actual condition and life expectancy of the tube. The extra tubes you will sell each day will pay for the FAST-CHECK in a very short time.

PICTURE TUBE TEST ADAPTER INCLUDED WITH FAST-CHECK

Enables you to check all picture tubes (including the new short-neck 110 degree type) for cathode emission, shorts and life expectancy . . . also to rejuvenate weak picture tubes.

RANGE OF OPERATION

- ✓ Checks quality of over 900 tubes types, employing the time proven dynamic cathode emission test. This covers more than 99% of all tubes in use today, including the newest series-string TV tubes, auto 12 plate-volt tubes. OZ4s, magic eye tubes, gas regulators, special purpose hi-fi tubes and even foreign tubes.
- ✓ Checks for inter-element shorts and leakage.
- ✓ Checks for gas content.
- ✓ Checks for life-expectancy.

SPECIFICATIONS

● No time consuming multiple switching . . . only two settings are required instead of banks of switches on conventional testers ● No annoying roll chart checking . . . tube chart listing over 900 tube types is located inside cover. New listings are added without costly roll chart replacement ● Checks each section of multi-section tubes and if only one section is defective the tube will read "Bad" on the meter scale ● 41 phosphor bronze beryllium tube sockets never need replacement ● 7-pin and 9-pin straighteners mounted on panel ● Large 4½″ D'Arsonval type meter is the most sensitive available, yet rugged — fully protected against accidental burn-out ● Special scale on meter for low current tubes ● Compensation for line voltage variation ● 12 filament positions ● Separate gas and short jewel indicators ● Line isolated — no shock hazards ● Deep brushed long lasting etched aluminum panel.

Housed in hand-rubbed oak carrying case complete with CRT ADAPTER

Model FC-2
$69.50 Net

TERMS: $14.50 within 10 days. Balance $11 monthly for 5 months.

NOTE: The Fast-Check positively cannot become obsolete . . . circuitry is engineered to accommodate all future tube types as they come out. New tube listings are furnished periodically at no cost.

MAIL FREE TRIAL COUPON TODAY!

CENTURY ELECTRONICS CO., INC.

111 Roosevelt Ave., Dept. 102, Mineola, N. Y.

☐	Model VT-10 Vacuum Tube Volt Meter $14.50 within 10 days. Balance $11 monthly for 4 months.	$58.50
☐	Model VT-1 Battery Vacuum Tube Volt Meter $14.50 within 10 days. Balance $11 monthly for 4 months.	$58.50
☐	Model CT-1 In-Circuit Condenser Tester $9.50 within 10 days. Balance $5 monthly for 5 months.	$34.50
☐	Model CRT-2 CRT Tester-Reactivator $13.50 within 10 days. Balance $11 monthly for 4 months.	$57.50
☐	Model FC-2 Fast-Check Tube Tester $14.50 within 10 days. Balance $11 monthly for 5 months.	$69.50

Prices Net F.O.B. Mineola, N. Y.

Yes, I want to take advantage of your 10 day FREE try-before-you-buy offer. Ship on approval the instruments I have checked. After I have tried the equipment for 10 full days I will either send you the down payment and agree to pay the balance in the monthly payments shown, or I will return the units and owe nothing.

Name ....
Please print clearly

Address ....

City .... State ....

ALL TUBES
INDIVIDUALLY BOXED . . .
UNCONDITIONALLY
GUARANTEED ONE YEAR
SEND FOR FREE COMPLETE
TUBE LIST & ORDER BLANK
INQUIRY PUTS YOU
ON MAIL-LIST

TELTRON
SMASHES PRICES
on TUBES for '60!

GIFT OFFER
ONE 6BG6G tube will be shipped **FREE** with any $10.00 or more order accompanying this ad.

FREE
$7.50 list value. Bonus box includes 3 6SN7 tubes & 25 assorted resistors & condensers with each order of $25.00 or more of receiving tubes and special purpose tubes only.

FREE
EICO TUBE
TESTER
By popular demand we are repeating this fabulous FREE GIVE-AWAY. You get this EICO tube tester kit #625K ABSOLUTELY FREE when you purchase $199.00 worth of receiving tubes from TELTRON within 60 days.
Tube tester may be purchased outright for $34.95 PREPAID. Send for FREE list of other EICO test equipment & HI FI components that we distribute.

PARTIAL LIST
MOST OFTEN USED TUBES

0Z4	.45	6BA8	.49	9U8	.79
1B3GT	.62	6BC5	.48	10DE7	.49
1R5	.51	6BC8	.59	12AB5	.44
1S5	.43	6BE6	.46	12AF6	.44
1T4	.51	6BF5	.48	12AT6	.37
1U4	.51	6BG6G	1.18	12AT7	.71
1U5	.43	6BH6	.51	12AU6	.43
1X2	.62	6BJ6	.51	12AU7	.58
2AF4	1.02	6BK5	.75	12AV6	.42
2BN4	.55	6BK7	.78	12AV7	.73
3AU6	.43	6BL7GT	.78	12AX4GT	.60
3BC5	.58	6BN4	.44	12AX7	.61
3BN6	.90	6BN6	.90	12AZ7	.65
3BZ6	.45	6BQ6GT	.83	12B4	.52
3CB6	.51	6BQ7A	.85	12BA6	.46
3DT6	.51	6BY5G	.75	12BE6	.46
3V4	.48	6BZ6	.45	12BH7	.61
4BC8	.69	6BZ7	.95	12BQ6	.63
4BQ7	.75	6C4	.41	12BY7	.65
4CB6	.51	6CB6	.51	12CR6	.43
5AM8	.59	6CG6G	1.63	12CU6	.63
5AN8	.64	6CF6	.45	12DB5	.59
5AT8	.54	6CG7	.44	12DQ6	.63
5AV8	.54	6CH8	.54	12K5	.44
5BK7	.68	6CM7	.44	12SA7	.45
5J6	.61	6CS6	.45	12SK7	.45
5T8	.59	6CU6	.95	12SN7GT	.56
5U4G	.43	6DE6	.43	12SQ7	.38
5U4GA	.45	6DG6GT	.50	12V6GT	.43
5U4GB	.45	6DQ6	.89	12L6GT	.43
5U8	.59	6H6	.47	12W6GT	.43
5V4G	.49	6J5	.49	17DQ6	.68
5X8	.55	6J6	.61	19AU4	.60
5Y3GT	.30	6K6GT	.39	19BG6G	1.48
6AB4	.43	6S4	.41	25BQ6GT	.82
6AC7	.65	6SA7	.45	25CD6G	1.19
6AF4	1.02	6SC7	.54	25CU6	.82
6AG5	.52	6SK7	.45	25L6GT	.41
6AH6	.47	6SL7GT	.60	25W4GT	.43
6AL5	.43	6SN7GT	.60	25Z6GT	.36
6AM8	.59	6SQ7	.38	35B5	.48

Send for FREE complete list of most often used tube types.

NEW AND HARD TO GET TYPES PROMPT DELIVERY

1DN5	.60
1G3GT/1B3	.70
2CY5	.50
3AF4	1.02
4DE6	.55
4DT6	.59
5CQ8	.59
6BJ8	.64
6BQ5	.74
6CQ8	.59
6CX8	.64
6DS5	.69
8AW8	.75
8CX8	.90
11CY7	.74
12EK6	.59
17AX4GT	.50
17D4.50 50EH5	.59

APPROX. COST ANY TYPE. EXCESS REFUNDED.

Obsolete, seldom used tubes. Immed. delivery.

1A6	.93	7B4	.44
1C5GT	.57	7B5	.41
1C7G	.39	7B8	.47
1F5	.39	7C5	.44
1H4G	.39	7F8	.77
1LA6	.66	7H7	.51
1LB4	.69	7N7	.52
1LH4	.66	7V7	.82
1LN5	.66	7Y4	.35
3LF4	.66	7Z4	.40
5T4	.59	12A8GT	.45
6A7	.59	12K7GT	.40
6A8	.40	12Q7GT	.48
6AB7/		12SR7	.57
1853	.60	14A7	.43
6AQ7GT	.60	14B6	.36
6AS7G	1.50	14Q7	.52
6D6	.59	27	.45
6F5GT	.44	35A5	.48
6F6	.42	35Y4	.35
6S7	.89	37	.59
6SB7Y	.50	39/44	.39
6SR7	.43	45	.55
6U5	.54	50A5	.48
6U7G	.40	50X6	.53
7A4/		56	.48
XXL	.47	71A	.65
7A6	.47	75	.44
7A8	.46	77	.55
7A7	.42	80	.40

Semiconductors for immediate delivery.

1N34	.49
1N38	.95
1N60	.34
1N66	.49
1N82A	1.00
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RADIO

(*Continued from page* 118)

to mix and handle. Epoxy resins are also somewhat more expensive than polyester types. These differences are not important since either type is more than adequate for cabinet repairs.

You can get complete kits of resin, hardener and Fiberglas at larger automobile or boat stores, or order the materials by mail from the Sears or Ward catalogs. Epoxy and Fiberglas kits have also been recently introduced to the electronics trade.

With its catalyst, 3 ounces of resin—enough to do as many as 10 ordinary repair jobs—costs only 40c. Kits with measuring cups, mixing paddle, Fiberglas assortment and about a pint of resin run from $0.95 to $2.30.

Using the resin

Accurate measuring and thorough mixing are extremely important, especially because mixing is usually done in small batches.

The proportions are by weight. However, some kits have paper measuring cups with markings on the side to indicate weight (by means of volume) for that particular resin.

We can best describe the mixing details by actually following a cabinet repair step by step. So let us look at Fig. 1 and begin repairing a cabinet that has a broken-out end.

First, tape the broken end into place by pressing masking tape firmly against one surface. Then pull on the free end of the tape and, at the same time, press it against the surface on the other side of the break.

Paper masking tape is ideal in this application. Filament-reinforced tape is even stronger and more tenacious, but is too tough to use conveniently on small repairs. Reserve filament tape for the big TV cabinets.

This pull-and-tape procedure provides several pounds of force, but obviously not enough to buckle or distort the case. If the case is properly pulled together, only a thin hairline crack will be left.

The next and most important step is the resin mixing. Fig. 2 shows the ideal arrangement, with a small balance or trip scale for weighing. This inexpensive balance sells for about $10 at photography stores. Of course, it is not an absolute necessity, but it is certainly a convenience for small mixing. Three or four repair jobs will pay for the scale.

The mixing utensils should be disposable. Paper cups and tongue depressors are available from drug stores at about two for a penny, make a good combination.

If a bowing pressure is applied to the edges of the depressor, it will break easily down the middle. This gives two-for-one and more convenience in reaching corners. Fig. 3 shows a half stick in use.

Always begin by spreading newspaper or paper towels on the working area. This is easier than cleaning spilled resin from the workbench.

Place a cup on the left side of the balance and make sure the sliding weight is completely to the left. Now balance the weight of the empty cup, placing weight on the right side of the balance. Bits of solder or small hardware will do.

Then place additional calibrated weights on the right, equal to the desired amount of resin, and add resin until the scale is again balanced.

As the last weighing step, slide the adjustable weight to the right—an amount equal to the required weight of the catalyst. Next, add catalyst to the resin until the scale balances. Around 5 or 6 grams of resin will be enough to repair the cabinet in the photographs.

Weights and measures

The gram is a very convenient unit of weight, based on the metric system. Approximately 28 grams equal 1 ounce.

Ordinary coins make convenient gram weights. A nickel weighs 5 grams. (This should be easy to remember!) A dime weighs 2.5 grams, a quarter 6.25 grams, and a fifty-cent piece weighs 12.5 grams.

Follow the directions on the resin container closely. Do not guess at the proportions or amounts.

To a very small extent, we shall violate this warning and suggest that 10% additional catalyst be used when mixing less than 10 grams. This compensates for catalyst that will be lost as a film on the mixing container and not mixed with the resin.

Whenever you see an unmixed drop of catalyst on the side of the cup, gather some resin on the mixing stick and smear it into the catalyst. Then push this into the central pool of resin and continue to stir. Never stir even a very small batch of plastic less than 2 minutes. Thorough mixing is important.

Most readers will not wish to invest in a balance scale. As a substitute, glue or tape two paper cups—one at each end of a foot ruler. Then pivot the ruler at exactly the 6-inch mark on a round pencil. Tape the pencil to the table so it will not roll. Now add bits of wire or solder until the cups balance or, just as good, almost balance.

This simple arrangement will tilt from one side to the other with less than 1/20 gram. This is even more sensitive than the photographic scale. However, it is not as convenient.

Use coins for weights of 2.5 grams or more. For smaller weights, cut a length of solder equal to 5 grams and divide it into five equal lengths. These will serve as gram weights. Divide them further for even smaller weights.

After mixing

When the resin and catalyst are mixed, immediately spread the mixture over the crack and ½ inch either side of the break. *Do this only on the inside of the cabinet.* See Fig. 3.

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Now spread Fiberglas filaments or fluff over the resin and work them into it with the wooden stick. Use enough Fiberglas to make a puttylike consistency. As necessary, smooth a slight amount of additional resin over the surface and the job is completed.

To get the Fiberglas filaments, cut coarse Fiberglas cloth (supplied with the kits) into small strips with scissors. The woven structure easily pulls apart, yielding large bundles of filaments.

Besides reinforcement, the Fiberglas keeps the resin from running or dripping while it is still liquid.

Through capillary action, the hairline crack fills flush to the outside surface. The crack is too small, however, for the resin to run out and mar the exterior.

Clear resin is suitable for repairing any color cabinet. Since the resin reduces the discontinuity at the surface, a clear resin-filled hairline crack is hardly noticeable.

If colored resins are attempted, any mismatch in color will cause the crack to stand out in contrast. Green, blue, red and white pigments are available for coloring the resin and possibly can be of some use in special applications.

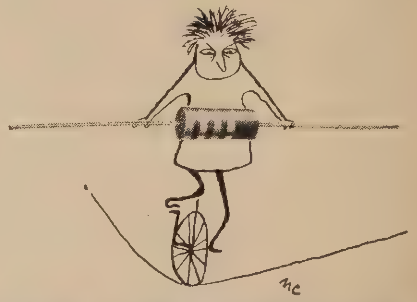
The resin will usually reach full hardness within 24 hours. Placing the cabinet in a warm part of the room hastens the hardening. But, under no circumstances, place a plastic cabinet near a heater. This is a direct invitation for a distorted (or even melted) cabinet.

Remove the masking tape, give the case a quick polish and the job is done.

Try patching a junked cabinet at leisure, to sharpen your technique before jumping into a rush customer job. Then, perhaps, you would like to repair the multimeter case that fell from the truck months ago and is now bandaged together with electrical tape?

For a case broken into three or more parts, join two pieces at a time, let the resin harden, and then join the resulting larger pieces. Even large TV cabinets may be handled this way without too much trouble.

Once you get the hang of it, a cabinet can be repaired in 20 minutes, including getting everything together and mixing the resin. The work can easily be handled by a helper or even the distaff section of the shop. END



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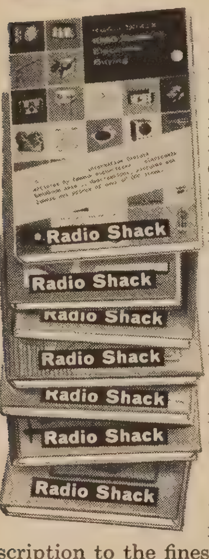

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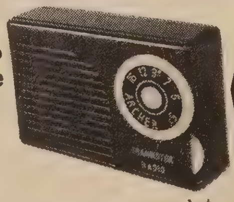

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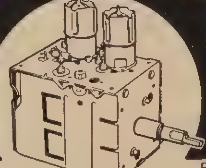

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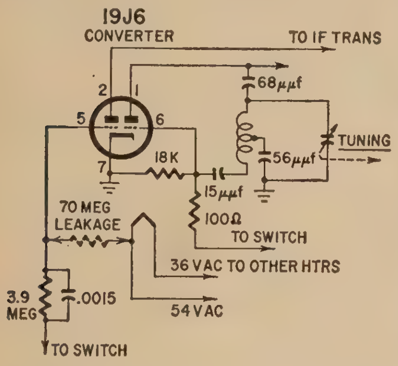
Att.: Service Mgr., Tuner Division
East Hillside Drive
Bloomington, Indiana

A Tough Dog!

By JAMES A. FRED

A RECENT radio repair job on an an RCA model 8X71 turned out to be a tough dog. An AM/FM table model, it had a bad case of hum modulation—hum that comes in only when a signal is tuned in. The set had been in another service shop before I got it.

Whenever I get a set that has been worked on like this one, I always get a circuit diagram and check it over before I start to work. I soon found that an electrolytic and two ceramic capacitors were missing from the FM discriminator circuit. I replaced these two parts plus a 35W4 that had been misplaced and found that the hum was still there.


19J6
CONVERTER
TO IF TRANS
2
1
5
6
7
68μμf
TUNING
56μμf
18K
15μμf
100Ω
TO SWITCH
70 MEG
LEAKAGE
36 VAC TO OTHER HTRS
3.9
MEG
.0015
54 VAC
TO SWITCH

I removed the tubes from the set and tested them on a mutual-conductance tube checker. All tested good.

When a visual examination failed to reveal anything wrong, I resorted to the old trick of listening for hum with a pair of headphones. I connected a .05-μf capacitor in series with one headphone lead and grounded the other. I then touched each pin of the 19J6 converter tube with the unconnected end of the capacitor while I listened for hum. I first tried pins 3 and 4 and naturally got a loud hum since these were the heater pins. I then went through the rest of them in order and heard a hum on pins 5 and 2, with the loudest hum on pin 2. This seemed to indicate that there was something wrong with the 19J6 so I took it out of the socket and checked for leakage with the highest resistance range of my vtvm. Between the heater and pin 5 there was a resistance reading of 70 megohms. Between all the other pins, the resistance reading was infinity. This leakage resistance allowed a small portion of the voltage on the heater string to leak through to the grid, where it modulated the incoming signal. The set now worked on AM, but was still dead on FM. I started another wire-by-wire check and found that a bypass capacitor had been soldered from grid to ground instead of from cathode to ground on the socket of the FM if amplifier. Rewiring one lead restored normal operation. END

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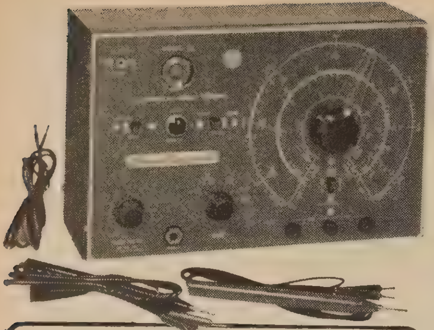

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The following components are all tested for QUALITY at appropriate test potentials. Two separate BAD-GOOD scales on the meter are used for direct readings.

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All Germanium Diodes.
All Silicon Diodes.

Model 79 comes complete with operating instructions and test leads. Use it on the bench—use it on calls. A streamlined carrying case included at no extra charge accommodates the tester, instruction book and test leads. Only ....

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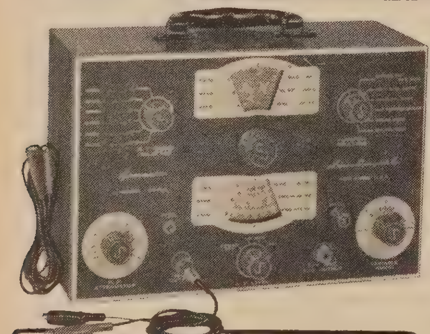

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- ✓ ***Bar Generator***
- ✓ ***Cross Hatch Generator***
- ✓ ***Color Dot Pattern Generator***
- ✓ ***Marker Generator***

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Model TV-50A—Genometer. Total price—$47.50—Terms: $11.50 after 10 day trial, then $6.00 monthly for 6 months if satisfactory. Otherwise return, no explanation necessary!

R. F. SIGNAL GENERATOR: The Model TV-50A Genometer provides complete coverage for A.M. and F.M. alignment. Generates Radio Frequencies from 100 Kilocycles to 60 Megacycles on fundamentals and from 60 Megacycles to 180 Megacycles on powerful harmonics.

VARIABLE AUDIO FREQUENCY GENERATOR: In addition to a fixed 400 cycle sine-wave audio, the Model TV-50A Genometer provides a variable 300 cycle to 20,000 cycle peak wave audio signal.

BAR GENERATOR: The Model TV-50A projects an actual Bar Pattern on any TV Receiver Screen. Pattern will consist of 4 to 16 horizontal bars or 7 to 20 vertical bars.

CROSS HATCH GENERATOR: The Model TV-50A Genometer will project a cross-hatch pattern on any TV picture tube. The pattern will consist of non-shifting, horizontal and vertical lines interlaced to provide a stable cross-hatch effect.

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THE MODEL TV-50A comes absolutely complete with shielded leads and operating instructions.

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SUPERIOR'S NEW MODEL TW-11

STANDARD PROFESSIONAL TUBE TESTER

Model TW-11—Tube Tester
Total Price $47.50
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★ Tests all tubes, including 4, 5, 6, 7, Octal, Lock-in, Hearing Aid, Thyratron, Miniatures, Sub-miniatures, Novals, Subminars, Proximity fuse types, etc.

★ Uses the new self-cleaning Lever Action Switches for individual element testing. Because all elements are numbered according to pin-number in the RMA base numbering system, the user can instantly identify which element is under test. Tubes having tapped filaments and tubes with filaments terminating in more than one pin are truly tested with the Model TW-11 as any of the pins may be placed in the neutral position when necessary.

★ The Model TW-11 does not use any combination type sockets. Instead individual sockets are used for each type of tube. Thus it is impossible to damage a tube by inserting it in the wrong socket.

★ Free-moving built-in roll chart provides complete data for all tubes. All tube listings printed in large easy-to-read type.

NOISE TEST: Phono-jack on front panel for plugging in either phones or external amplifier will detect microphonic tubes or noise due to faulty elements and loose internal connections.

EXTRAORDINARY FEATURE

SEPARATE SCALE FOR LOW-CURRENT TUBES: Previously, on emission-type tube testers, it has been standard practice to use one scale for all tubes. As a result, the calibration for low-current types has been restricted to a small portion of the scale. The extra scale used here greatly simplifies testing of low-current types.

The Model TW-11 operates on 105-130 Volt 60 Cycles A.C. Comes housed in a handsome portable saddle-stitched Texon Case. Only $47.50

SUPERIOR'S NEW MODEL 82A

Multi-Socket Type TUBE TESTER

Model 82A—Tube Tester
Total Price $36.50
Terms: $6.50 after 10 day trial, then $6.00 monthly for 5 months if satisfactory. Otherwise return, no explanation necessary.

TEST ANY TUBE IN 10 SECONDS FLAT!

① Turn the filament selector switch to position specified.

② Insert tube into a numbered socket as designated on our chart (over 600 types included).

③ Press down the quality button—

THAT'S ALL! Read emission quality direct on bad-good meter scale.

SPECIFICATIONS

- Tests over 600 tube types
- Tests OZ4 and other gas-filled tubes
- Employs new 4" meter with sealed air-damping chamber resulting in accurate vibrationless readings
- Use of 22 sockets permits testing all popular tube types and prevents possible obsolescence
- Dual Scale meter permits testing of low current tubes
- 7 and 9 pin straighteners mounted on panel
- All sections of multi-element tubes tested simultaneously

Ultra-sensitive leakage test circuit will indicate leakage up to 5 megohms

Production of this Model was delayed a full year pending careful study by Superior's engineering staff of this new method of testing tubes. Don't let the low price mislead you! We claim Model 82A will outperform similar looking units which sell for much more — and as proof, we offer to ship it on our examine before you buy policy.

To test any tube, you simply insert it into a numbered socket as designated, turn the filament switch and press down the quality switch — THAT'S ALL! Read quality on meter. Inter-element leakage if any indicates automatically.

Model 82A comes housed in handsome, portable Saddle-Stitched Texon case. Only $36.50

SUPERIOR'S NEW MODEL 83

C.R.T. TESTER

TESTS AND REJUVENATES ALL PICTURE TUBES

Model 83—C.R.T. Tube Tester
Total Price $38.50
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ALL BLACK AND WHITE TUBES

From 50 degree to 110 degree types —from 8" to 30" types.

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Test ALL picture tubes—in the carton—out of the carton—in the set!

- Model 83 is not simply a rehashed black and white C.R.T. Tester with a color adapter added. Model 83 employs a new improved circuit designed specifically to test the older type black and white tubes, the newer type black and white tubes and all color picture tubes.
- Model 83 provides separate filament operating voltages for the older 6.3 types and the newer 8.4 types.
- Model 83 employs a 4" air-damped meter with quality and calibrated scales.
- Model 83 properly tests the red, green and blue sections of color tubes individually—for each section of a color tube contains its own filament, plate, grid and cathode.
- Model 83 will detect tubes which are apparently good but require rejuvenation. Such tubes will provide a picture seemingly good but lacking in proper definition, contrast and focus. To test for such malfunction, you simply press the rej. switch of Model 83. If the tube is weakening, the meter reading will indicate the condition.
- Rejuvenation of picture tubes is not simply a matter of applying a high voltage to the filament. Such voltages improperly applied can strip the cathode of the oxide coating essential for proper emission. The Model 83 applies a selective low voltage uniformly to assure increased life with no danger of cathode damage.

Model 83 comes housed in handsome portable Saddle Stitched Texon case—complete with sockets for all black and white tubes and all color tubes. Only..... $38.50

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☐ Model TW-11...........Total Price $47.50 $11.50 within 10 days. Balance $6.00 monthly for 6 months.
☐ Model 82A...............Total Price $36.50 $6.50 within 10 days. Balance $6.00 monthly for 5 months.
☐ Model 83..................Total Price $38.50 $8.50 within 10 days. Balance $6.00 monthly for 5 months.

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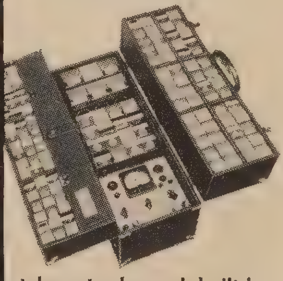

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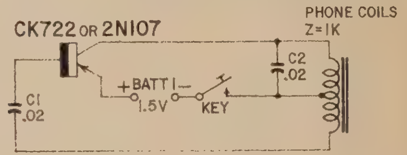
RADIO

ECONOMY CODE OSCILLATOR

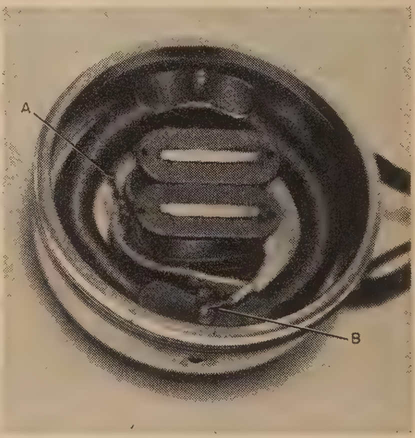
By JAMES MARTIN

IF economy is important to you when constructing a code-practice oscillator, this one is for you. It consists of five inexpensive components, a low-priced transistor, a standard earphone, two small capacitors and a 1.5-volt flashlight battery.

The unusual part of the circuit is that the earphone is used as a tapped choke to provide feedback. This eliminates the expensive transformer or tapped choke.



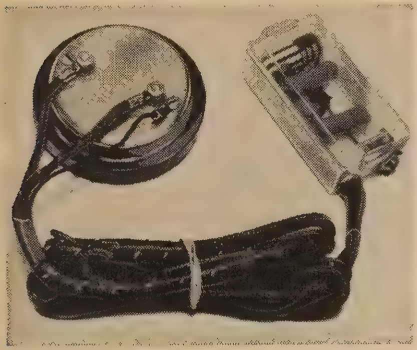
As the diagram shows, the tap is made at the connection between the two coils. Most phones contain two coils, and the connection between them is usually easy to get at. A short length of wire is soldered to this connection (point A in photo) and neatly led around and soldered to one of the screws that hold the magnet down (point B in photo). A wire, the length of the phone cord, is also secured to the screw. It is taped securely to the phone cord at 4- or 5-inch intervals.



The circuit is fairly simple. The feedback that maintains oscillation is obtained from the phone coil and fed back to the transistor's floating base.

The operating frequency is determined chiefly by the values of capacitor C2 and the inductance of the phone coil that C2 is connected across. Current drain runs from about 100 to 200 μa, depending on the particular transistor used.

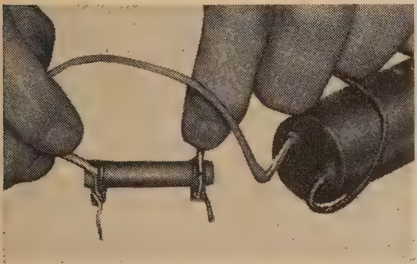
Construction is no problem. The oscillator can easily be assembled in a small plastic box. I used a miniature jack and plug to connect the key to the oscillator, but this is optional and the wires may be connected directly to the key.



With most transistors, volume will be extremely high, and, in all probability, a resistor will have to be placed in series with the key to hold the volume down to a more comfortable level. The value of this resistor will depend on the volume desired. Of course a potentiometer could be inserted to give variable control of volume. END

DISCHARGING ELECTROLYTICS

The common practice is to discharge electrolytic capacitors by shorting their terminals together or by placing a metallic tool across the terminals. This practice is satisfactory for small-value capacitors but may damage larger units such as the photographic flash types and those over 40 μf used in radio and television. The strain on the large dielectric area is too sudden and may cause a puncture of the dielectric film, producing leakage or a short circuit thereafter.



Large capacitors should be discharged through a resistor (see photo). After the initial surge the terminals may then be short-circuited.—*A. R. Clawson.*

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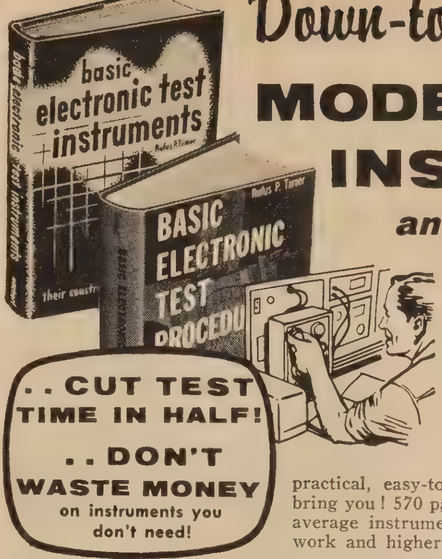
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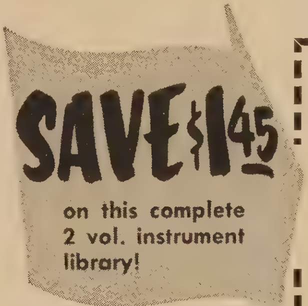
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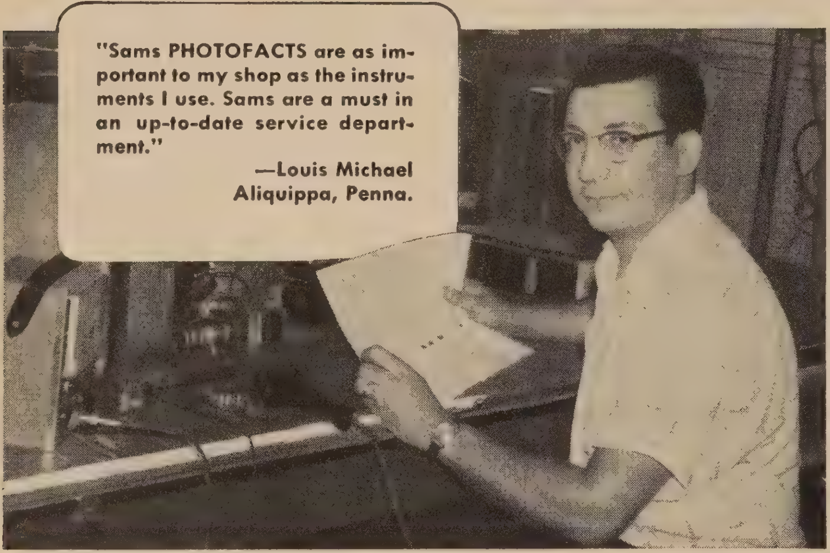

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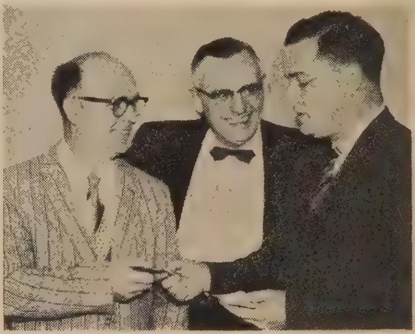
TECHNICIANS' NEWS

N. C. CERTIFIES TECHS

The certification of TV technicians as "journeyman TV technician" or as "television technician," based upon examinations or successful completion of state-sponsored courses is proceeding in North Carolina.

In the photograph, State legislator Ed Kemp (right) is presenting to J. L. Warren, president of the High Point (N. C.) Radio & TV Technician's Association, a card identifying him as a certified technician.



The program was established by the state's Vocational Education Division with the help of the North Carolina Federation of Electronic Technicians (NCFEA) and is now being offered at 13 centers throughout North Carolina.

Interested technicians may contact L. L. Leathers, president of the NCFEA, at 221 Sutherland St., Durham, or their local Director of Vocational Education.

MICHIGAN SERVICE COSTS

TSA (Michigan) sponsored a business training course starting in October, 1959, with representatives from RCA, G-E, Bell Telephone and others participating. Brought out in panel discussions at the first meeting were these interesting figures for the 50 members of TSA at the session.

Average labor charges were from $7.95 to $9.50 for a 1-hour home call.

Average for shop repairs was from $24.50 to $35.

Average pickup and delivery charges ran from $9 to two full call charges.

The clinics which continue at one per month (2½ hour sessions), were scheduled through March. They're strictly on business; nothing technical.

DEL. VALLEY GROUP HITS RETAILING WHOLESALERS

An editorial in the *TSA News* (Delaware Valley) headed "Loose Distribution Deserves Just Retribution" discusses wholesale parts distributors who sell to retail customers. Recommending

ARE YOU ON THE LIST?

Radio-Electronics is publishing a detailed list of the known television service associations in North America. If you belong to an association that isn't on our list or want to get the name and address of the one closest to you, drop a postcard to: Association Editor, Radio-Electronics, 154 West 14 Street, New York 11, N.Y.

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Keith Kirstein, President

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Box 126
Van Nuys, Calif.
Arnold Meyer, President

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G. P. R. Christensen, President

that members of TSA–Delaware Valley patronize jobbers who refuse to sell at retail, *TSA News* points out that possession and use of a state sales-tax number in these sales is a good guidepost to a jobber who wants to sell only to dealers.

TECHNICIAN SHORTAGE IN CALIFORNIA

There is a shortage of good TV technicians, says IPET, organ of the Society of Radio & Television Technicians, Van Nuys, Calif., in an editorial. "The fact remains that today the shortage of good trained technicians is more acute than at any time in electronics' short history. Every day more technicians leave for greener fields because they can make more money with less grief and less work. Hardly a day goes by that some shop doesn't call asking for a good outside man or a top bench man.

"Still the top wages offered to these men is nowhere near what they can get at any local factory or manufacturer. Why does this condition exist? Why can't the local TV shop meet the prices paid by industry in general? Here again we must face facts. Shops that are still charging 1949 prices simply can't pay 1959 labor costs . . . Until the industry raises its standards and its prices I'm afraid good technicians are going to be hard to find . . ."

OPPOSES LICENSING

TEAM News (Mo.) says: A license . . . will give dignity to the shop that cannot hold a customer now because of a lack of ethics . . . it will produce a new field for the people who grow fat on 'payoffs' and will introduce the evils of the bribe, pressure and outside control to this industry, which has managed to maintain its integrity and independence despite the efforts of some opportunists inside and outside of the industry.

"It is ridiculous to try to put teeth in existing laws to cover one industry and bypass all others. What good does it do to protect the public from the unscrupulous TV man when some unscrupulous doctor, lawyer, real estate agent, insurance man, plumber, electrician, mechanic, clothing salesman, furniture salesman, undertaker, interior decorator, tree surgeon, butcher, baker and candlestick maker is waiting to get the hook into him? And most of them with a big fat license to back up the action?"

FLORIDA TECHS TO ASK LICENSING

TESA (Miami) announced plans to ask the Dade County (Florida) Board of Commissioners to license and regulate radio–TV service technicians through an ordinance. TESA plans included an apprentice training program, made provision for already practicing technicians who are paying municipal taxes properly through a "grandfather" clause.

One reason licensing was needed, TESA stated, was that over half a dozen people in Dade County had been killed by improperly installed electronic devices during 1959.

TEXAS LAW WORKING

In the *NATESA Scope* president Mac Metoyer writes, "It is interesting to note . . . that most letters crossing my desk refer to shops everywhere having good business. Oren Wunsch of Beaumont, Texas even called long distance trying to locate service technicians.

"He explained that with the new Texas state sales tax law, part-time TV 'fixit' men have virtually gone out of the field. The Texas law requires a consumer to pay sales tax to the vendor. The vendor must have a tax collection permit, and must post a bond in favor of the State of Texas to insure payment. The bonding companies require definite proof of one being in business before

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"Servicing Hi-Fi and FM in the Customer's Home"

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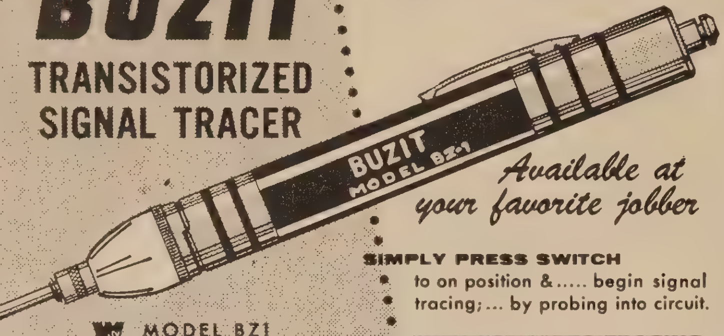

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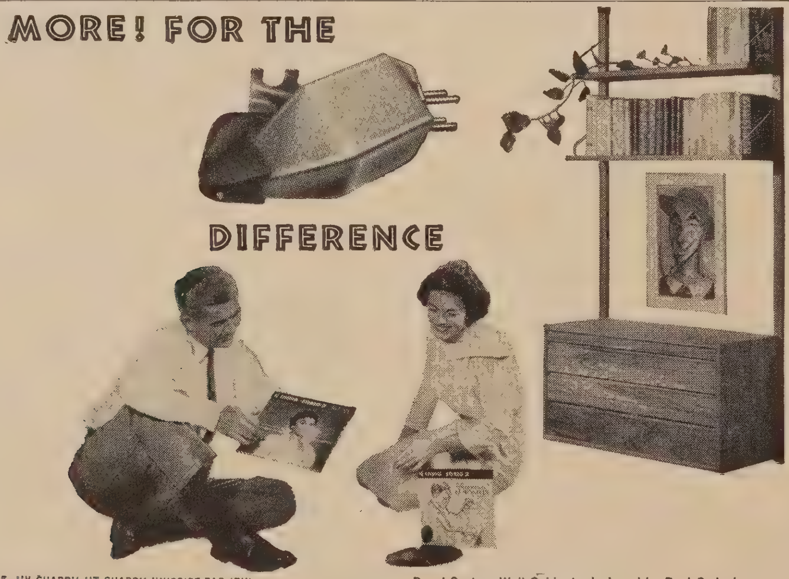

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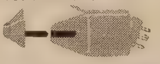

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they will bond the firm. This means a place of business and a minimum investment. To sell retail (to the consumer) without a tax permit is a felony.

"Even though this new law includes all businesses, it has been a great aid to the established electronic service firms."

ESFETA SECRETARY RESIGNS

George Carlson, secretary of the Empire State Federation of Electronic Technicians Associations, and Eastern secretary of the National Alliance of TV & Electronic Service Associations, has resigned from his ESFETA post to devote his full time to NATESA duties. Carlson is also active in his local group, Electronic Technician's Association, Jamestown, N. Y.

ST. LOUIS TECHNICIANS GIVE SETS TO NEEDY

As part of their expression of the Christmas spirit the members of TESA–St. Louis voted to repair radio sets and give them to the Volunteer Bureau of the Health & Welfare Council of St. Louis, Mo. Most members of the group indicated they had at least one old receiver around the shop, and would repair it for the cause. A local parts distributor, Crown Electronics, generously volunteered to supply needed parts to service dealers participating in this Christmas program.

TUBE-CADDY THIEVES MOVE TO BURGLARY

Miami service technicians, plagued by a series of thefts of tube caddies from their trucks and cars while out on calls, have nothing on parts jobber Vance Baldwin, Inc., of 7700 N.W. 7th Ave., Miami, who recently lost 8,000 tubes, a tube tester, tape recorder and an amplifier to thieves. The robbers broke into the store at night.

ARTSNY RAISES DUES

The Associated Radio & Television Technicians of New York City increased their dues to $35 a year from a former figure of $18. On a show of hands, only two members were not in favor of the proposed increase. END

Answer to Tape Recorder Word Puzzle on page 43

1 T	A	P	2 E	▨	3 I	R	O	N	▨	▨	▨	4 G	A	P
H	▨	▨	D	▨	N	▨	▨	▨	▨	▨	▨	U	▨	▨
5 R	E	W	I	N	D	▨	6 P	L	A	S	T	I	C	▨
E	▨	▨	T	▨	I	▨	A	▨	▨	▨	▨	D	▨	7 R
A	▨	8 T	▨	9 A	C	E	T	A	10 T	E	▨	E	▨	E
11 D	U	A	L	▨	A	▨	C	▨	R	▨	▨	▨	▨	S
▨	▨	K	▨	▨	T	▨	12 H	E	A	D	▨	13 L	▨	P
14 S	T	E	R	E	O	▨	▨	▨	C	▨	▨	E	▨	O
P	▨	U	▨	▨	R	▨	15 M	I	K	16 E	▨	V	▨	N
L	▨	P	▨	▨	▨	▨	A	▨	▨	17 R	E	E	L	S
I	▨	▨	▨	18 M	▨	▨	G	▨	▨	A	▨	L	▨	E
C	▨	▨	19 W	O	W	▨	N	▨	▨	S	▨	▨	20 B	▨
E	▨	▨	▨	T	▨	21 L	E	A	D	E	R	▨	I	▨
▨	▨	▨	▨	O	▨	▨	T	▨	▨	▨	▨	▨	A	▨
22 R	E	C	O	R	D	▨	▨	23 B	R	A	K	E	S	▨

Technotes

WESTINGHOUSE H21T104

On humid days the receiver would overload on strong signals. The set would behave satisfactorily when relative humidity was low.

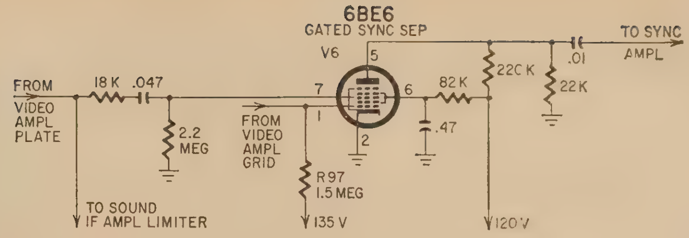
The condition was simulated in the shop with a squirt from a perfume atomizer. A gentle spray on the wiring side of the printed chassis board near the keyed agc tube section (half of a 5BT8, pentode section) produced the symptom.

The wiring board around the socket was carefully cleaned. This did away with a leakage path between lugs 7 and 8. The leakage reduced the agc by reducing the video signal applied to the grid, pin 8. The area was sprayed with high-voltage dope after it was cleaned.—*E. A. Chung*

STEWART WARNER 21T9300A

The set developed extremely critical and unstable sync. Low-amplitude sync pulses were evident when the waveform at the integrator's output was examined.

Resistance checking revealed a trifle low tolerance on the grid resistor of the gated sync clipper, a 6BE6. Replacing the resistor, R97, solved the problem. —*Mark Wilson*

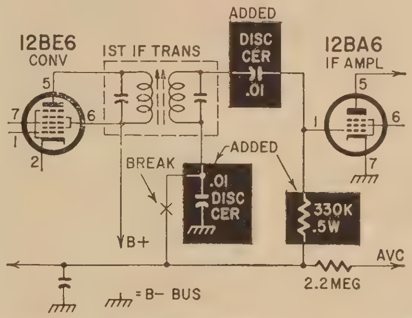


LEAKY IF TRANSFORMER

Rather than replace or repair a leaky miniature if transformer, I find it quicker and cheaper to block the secondary winding against the leaking plate voltage with a couple of .01-μf ceramic disc capacitors.

In the G-E model 572 used as an illustration, the leak kept the grid of the 12BA6 at 0.5 volt dc, regardless of any avc action which still managed to come through on strong local stations. The increased plate current in the 12BA6 lowered plate and screen voltages in the set from the 95 called for in the schematic to 85. Voltage returned to normal after the repair.

Typically, the leakage resistance between the two windings of the if transformer could not be measured with the ohmmeter section of my vtvm.—*E. T. Thiersch*



MODEL BK 414 SOUNDMIRROR

Distortion of the sound that appears as a sort of gurgling or gargling of the voice and music is caused by too little bias on the amplifier tubes. The case in point had a leaky capacitor coupling the first amplifier (6J7) to the second amplifier, a 6SJ7. The value of this capacitor is .005 μf. It should be replaced with a 600-volt molded-paper unit.—*Lawrence Shaw* END

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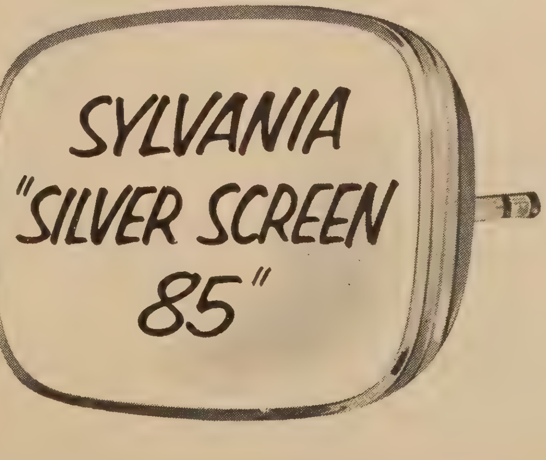
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new PATENTS

BEAM REGISTRATION CIRCUIT

Patent No. 2,885,594

Arnold Lesti, Kensington, Md. (Assigned to Andromeda, Inc., Kensington, Md.)

This patent deals with color kinescopes whose targets are coated with phosphor strips. As a strip is scanned, it emits a primary color. The phosphors exist in groups of three—red, blue and green. Each blue phosphor is processed so it also emits a short-persistence violet light which is transmitted through a filter onto a photocell.

The tube's gun emits a trio of closely spaced beams which scan the corresponding phosphors as a unit (Fig. 1). The incoming TV signal controls the intensity of each beam and thus determines whether red, blue, green, or any combination thereof, becomes visible at a given time and point. This invention solves the problem of beam alignment so the proper phosphor is scanned by the correct beam.

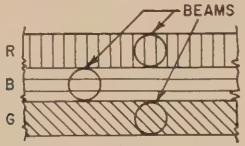

Fig.1

Fig. 2 shows chrominance signals at the grids of the kinescope. The luminance (—Y) signal is applied at all cathodes. A pilot frequency modulates the upper and lower cathodes as shown, thus superimposing a high frequency on them.

Consider what happens when the beams are out of alignment. If the triple beam is too low, the beam corresponding to *red* will fall (at least partly) on the *blue* phosphor. Since the red (upper) cathode is modulated at pilot frequency, the photocell will receive an hf-modulated violet light. On the other hand, if the beam is too high, the green beam will modulate the blue phosphor. Again the photocell will deliver output, this time of opposite phase (because the upper cathode is out of phase with the lower, with respect to the pilot frequency).

A phase detector receives the pilot frequency signal and generates dc which may be positive or negative.

The output is fed back (through smoothing and corrective networks, not shown) to auxiliary deflection plates. They raise or lower the beam as required for accurate registration.

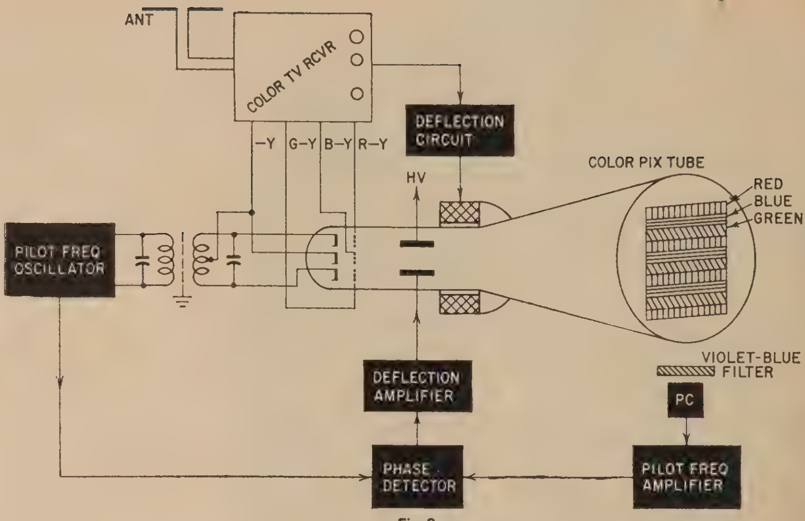

Fig.2

BATTERY-LESS RADIO

Patent No. 2,813,242

Lloyd R. Crump, Silver Spring, Md. (May be used by US Government without payment of royalties)

Transistors require so little power that broadcast radiation may be sufficient. Several such circuits have been described in this magazine: April 1957, page 85; April 1955, page 96.

This radio uses a full-wave rectifier to extract maximum radiation power from an antenna. Coil L1 is tuned to the desired signal, which is detected by diode D1, then amplified by transistor V.

Coils L2 and L3 are tuned to the strongest local transmitter, not necessarily the same as the desired signal. One circuit delivers positive voltage to C1, the other charges C2 negatively.

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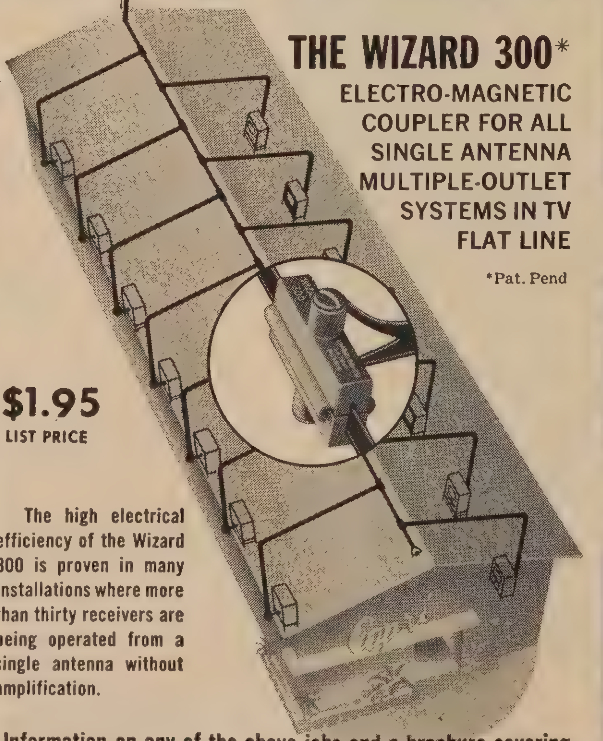
HOTEL – 120 Outlets–One Antenna–One Amplifier: The Montecito–6650 Franklin, Hollywood, California.



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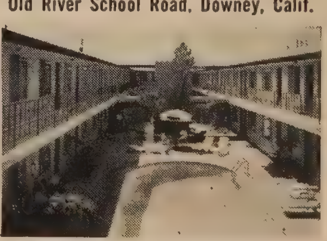
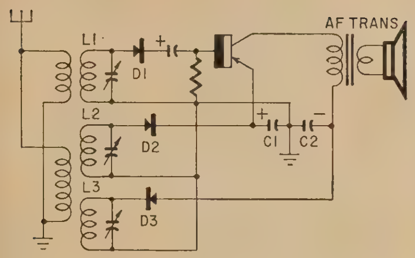


APARTMENT–48 Outlets–Two Antennas (24 Outlets each) – No Amplification: The Paramount Riviera – 12447 Paramount Blvd., Downey, California.



These capacitors energize V with correct polarity.

The inventor finds that with indoor antenna pickup from a 5-kw transmitter 5 miles away, he generates up to 3 volts at 250 μa.

DIODE PULSE AMPLIFIER

Patent No. 2,892,979

William A. Ogletree, Southampton, Pa. (Assigned to Burroughs Corp., Detroit, Mich.)

This pulse amplifier works on the principle that a conducting diode cannot immediately be switched to nonconduction. Its back resistance remains low for a few microseconds, depending upon the prior forward flow. Here a 1N91 diode is blocked periodically by a clock pulse of 0.1-μsec duration and 40-volt amplitude. Forward flow is provided by plate current which can vary from zero to 2 ma (see Fig. 1).

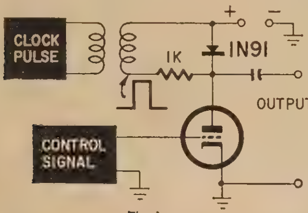


Fig. 1

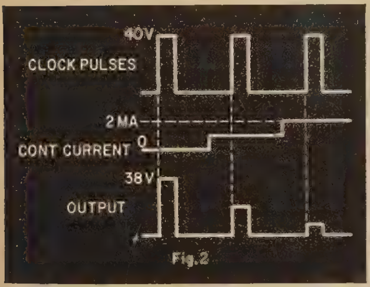
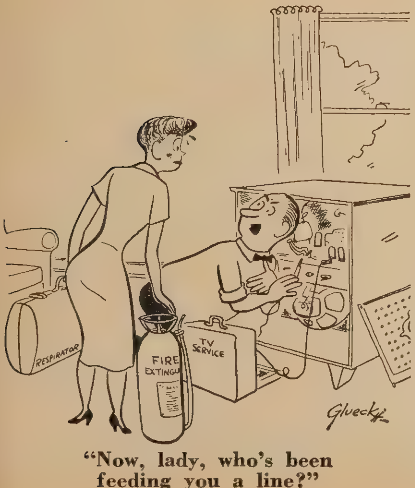


Fig. 2

When blocked by a reverse clock pulse, the 1N91 back resistance may vary from several hundred thousand ohms (no prior flow) to a few ohms (2-ma prior flow). Since the diode shunts the output terminals, it controls the output. Fig. 2 shows how the output pulse depends upon the control current. Note that output pulses occur only during a clock pulse. END



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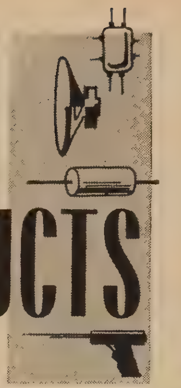
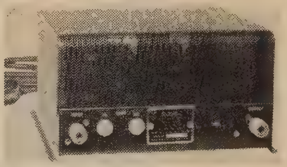
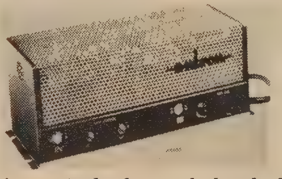


TV AMPLIFIER *model MLA-B*. Gain 40 db, output 1.7 volts on separate high- and low-band outputs. Response within 1 db overall, within ½ db on any channel. Separate gain and 6-db tilt controls each band.—**Blonder-Tongue Laboratories, Inc.,** 9 Alling St., Newark 2, N.J.



TV MASTER AMPLIFIER *model SA-23* 38-db gain, 2 bands, channels 2–6 and 7–13. Tilt and gain controls for each band. 6 lbs, 12 x 4½ x 5 in.—**Entron, Inc.,** Box 287, Bladensburg, Md.



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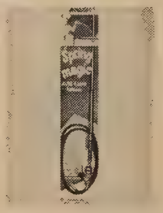

FM AUTO ANTENNA *model Halo* fits over standard AM car antennas, eliminating hole drilling. Aluminum loop. Improves AM reception.—**Clear Beam Antenna Corp.,** 21341 Roscoe Blvd., Canoga Park, Calif.

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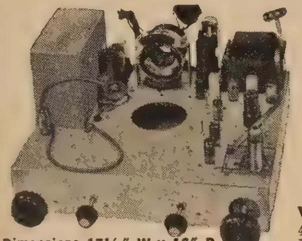
70° or 90° — operating all 17", 21", 24" and 27" PICTURE TUBES



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Shipping weight 40 lbs.

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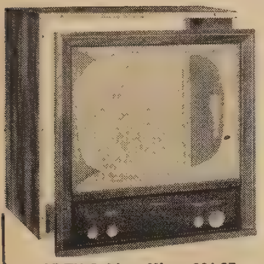

Comparable to the type that Top Mfrs. use on high priced TV sets.

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Front, Top and Sides supplied in a beautiful Piano Finish ● Knob panel undrilled ● For matching Mask specify type or number of CRT used. Same price—Mahogany, Walnut or Blond. (Shipping weight 36 lbs.)

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½ WATT 10% 39k, 47k, 50k, 56k, 68k, 82k, 100k, 120k, 150k, 180k, 220k, 270k, 330kΩ. . . . 2¢ ea.
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1 WATT 10% 3.3, 10, 39, 100, 120, 150, 330, 470, 560, 680, 820, 1k, 1800, 2700, 4700Ω. . 3¢ ea.
1 WATT 10% 6800, 10k, 15k, 18k, 22k, 27k, 33k, 39k, 47k, 68k, 82k, 100k, 150k, 470k, 680kΩ 3¢ ea.
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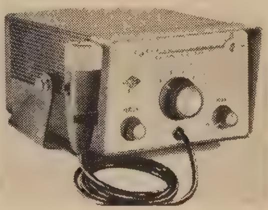
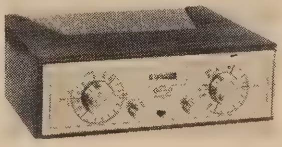
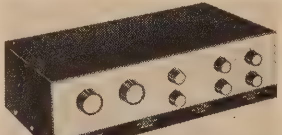


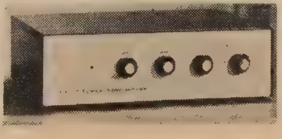
STEREO TUNER *model 330-D.* 2 tuners on one chassis. FM sensitivity 2.5 μv by IHFM standard. AM wide-range detector; 3-position AM pass-band switch. Tuning meter switches to FM or AM. Wood case optional.—**H. H. Scott, Inc.,** 111 Powdermill Road, Maynard, Mass.



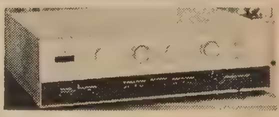
STEREO PREAMP KIT *PAS-2* includes tape-head channels and extra-low-level channel for user to wire for microphone, extra tape head, second set of magnetic pickups, etc. Built-in power supply provides dc heater power. Distortion under 0.5% at normal levels, noise 74 db down. Response within 0.5 db 10–40,000 cycles. Also available factory-wired.—**Dynaco, Inc.,** 3916 Powelton Ave., Philadelphia 4, Pa.



STEREO AMPLIFIER. Economy *model KN-520* has dual 10-watt units separate bass and treble controls each channel. Response ±1 db from 40–15,000 cycles. Distortion 1.5% at 50 cycles, 0.5 % at 20 kc. Hum and noise 40 db below rated output at magnetic phono input. Complete with metal case.—**Allied Radio Corp.,** 100 N. Western Ave., Chicago 80, Ill.



STEREO AMPLIFIER deluxe *model KN-760* has dual 30-watt units. Concentric clutch type tone controls, continuously variable stereo separation–blend control, 3-position loudness compensation switch. Stereo channel outputs mixed for third (center) channel speaker. Response 25 to 20,000 cycles within ±0.5 db. IM distortion under 2% at rated output. Hum, noise 54 db down at phono inputs, 47 db down at tape-head input. Silicon rectifier supply.—**Allied Radio Corp.,** 100 N. Western Ave., Chicago 80, Ill.



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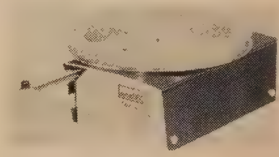

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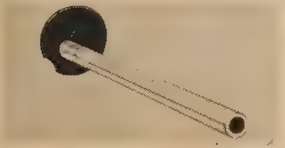

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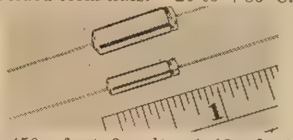

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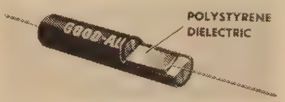

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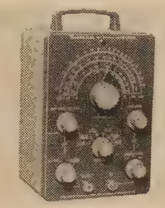
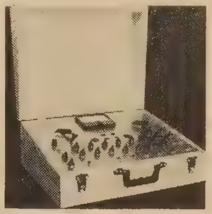


ELECTRON-TUBE ANALYZER *model ETA-100B* enables positive evaluation and matching of tubes. Measures true plate, screen current, transconductance at precise voltages. Gas and leakage test continuously variable to 10 megohms. Determines firing point of thyratrons, regulation of gas-tube regulators, forward and reverse current of small dry-disc rectifiers and diodes. Supplies continuously variable dc voltage for outside circuits 0–100 volts, 50 ma; 0-450 volts 300 ma. Two negative sources from 0-100 volts at 50 ma.—**American Scientific Development**, Box 404, Janesville, Wis. END



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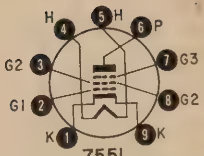
NEW TUBES and SEMI-CONDUCTORS

VACUUM tubes dominate the field this month. There is a vhf TV rf amplifier, a frame-grid amplifier for TV if stages and a beam power tube for mobile communications equipment.

7551

A beam power tube in a 9-pin miniature envelope, the 7551 is designed for reliable service in mobile communications equipment operating from a 12-volt battery system. The 7551 is particularly useful as a class-C rf amplifier, oscillator, or frequency multiplier, at frequencies up to 175 mc. It can also be used in modulator and audio power amplifier applications.



7551

Typical operating characteristics of the RCA 7551 as an rf amplifier at 175 mc are:

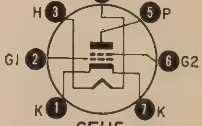
	CCS*		ICAS†
V_P	250	300	300
G3	connected to cathode		
V_{G2}	200	200	250
V_{G1}	—40	—42	—55
V_{G1} (peak rf)	47	52	62
I_P (ma)	60	70	80
I_{G2} (ma)	3.7	3.7	5.1
I_{G1} (ma) (approx)	1.5	2.1	5.1
P_{driver} (watts) (approx)	1	1	1.5
P_{output} (watts) (approx)	6.5	8.5	10

*Continuous Commercial Service

†Intermittent Commercial and Amateur Service

6FH5

A semi-remote cutoff tetrode of the 7-pin miniature type intended for use —triode connected—in grounded-cathode rf amplifier circuits of vhf TV tuners. Grid 2, primarily intended as a shield, provides low capacitance be-



6FH5

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TV-RADIO SERVICE

Dave Rice's OFFICIAL ORDER BOOK

ELECTRONIC PUBLISHING CO., INC.
180 N. WACKER DRIVE
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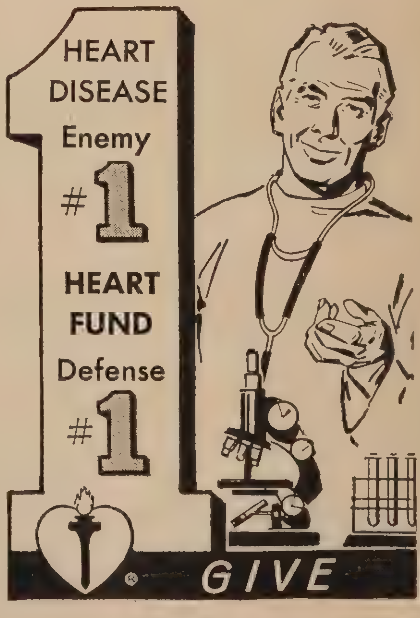


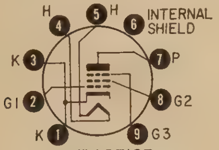
tween grid 1 and plate to facilitate neutralization and reduce oscillator radiation. When connected as a triode, the RCA 6HF5 features high transconductance at low plate voltage to provide high gain.

Characteristics of the 6FH5 in Class-A1 amplifier service with its cathode connected to grid 2 are:

V_P	135
V_{G1}	−1
R_P	5,600
gm (μmhos)	9,000
μ	50
I_P (ma)	11
V_{G1} for I_P = 100 μa	−5.5
V_{htr}	6.3
I_{htr} (ma)	200

6EH7/EF183

A frame-grid remote-cutoff pentode designed for use as an if amplifier in TV receivers. Its high transconductance, low interelectrode and feedback capacitances make possible the construction of simplified broad-band amplifiers with high stability.



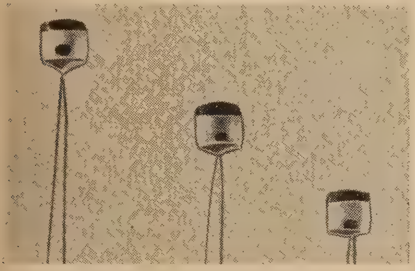
6EH7/EF183

Typical operating characteristics of the Amperex 6EH7/EF183 are:

V_P	200
V_{G2} supply	200
V_{G3}	0
R_{G2} (series) (ohms)	27,000
V_{G1}	−2
gm (μmhos)	12,500
I_P (ma)	12
I_{G2} (ma)	4.5
R_P (ohms)	500,000
R_{input} (ohms)	11,000

Selenium diodes

These subminiature plastic-encapsulated units have been developed by Radio Receptor. Capable of operating in temperatures between −50°C and 100°C without derating, the diodes come in eight types with peak-inverse-voltage ranges of 50–400 at 12.5 ma. Maximum case length is only 0.380 inch with widths ranging from 0.340 to 0.480 inch. Applications cover computers, business machines, arc suppressors, power supplies, radios, TV sets, hearing aids and electric games.



7558

A beam-power tube in a 9-pin miniature envelope designed for use in fixed-

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Everything you need for less than $50

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Accurately checks all transistors in hearing aids, radios and power transistors in auto radios. Tests for opens, shorts, leakage, current gain. Measures forward-reverse current ratio on all crystal diodes. Measures forward and reverse currents on selenium rectifiers. With set-up chart for accurate checking of each transistor. Size, 5x4½x2½". With batteries. DEALER NET................ 17.95

Replace Batteries During Repair . . .

SENCORE PS103 BATTERY ELIMINATOR

All-new "Transi-Pak," twin to TRC4 Checker above. Provides variable DC voltage to 24 volts; 1.5-volt biasing tap (a"must" for servicing Philco and Sylvania radios). Metered current output, to 100 ma. Handles 200-ma peaks. Two 200-mfd electrolytics provide proper filtering and low output impedance. No hum or feedback problems. Ideal for alignment using station signal; adjust IF slugs for max. current, also ideal for charging nickel-cadmium batteries. Size, 5x4½x2½". DEALER NET......................... 17.95

Find Defective Stage in a Minute . . .

SENCORE HG104 HARMONIC GENERATOR

New signal generator designed primarily for fast signal-tracing of transistor radio circuits. No need to unsolder all transistors. Provides RF, IF and audio signals *simultaneously*, drastically cutting service time. Traces from speaker to antenna. Clear 1000 cycle note signal is heard in speaker from all good stages. Signal weakens or stops at defective stage. Equally as effective for testing TV, hi-fi and other audio circuits also. Size, 3½x4½x1¾". With batteries. DEALER NET.......... 9.95

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(*Continued on p.* 145)

why your next speaker system should be

THE NEW AUDAX PARAFLEX

- Only Audax incorporates the **Patented Paraflex Foam Suspension** to give longer travel to the cone, resulting in honest bass without boom or hangover. You get bass with real bottom!
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Model CA-80 12" x 12" x 24" with two full range speakers—$99.95

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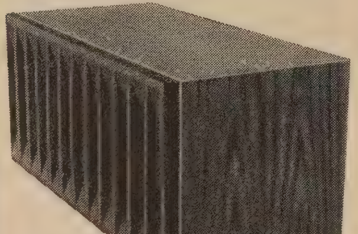
Also full line of component speakers



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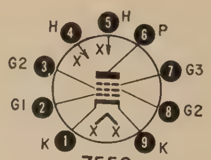


7558

station communications equipment. The 7558 is particularly useful in class-C rf amplifier, oscillator and frequency-multiplier service up to 175 mc. It can also be used in modulator and audio-frequency power amplifiers.

Maximum ratings of the RCA 7558 as an rf power amplifier and oscillator (class-C Telegraphy) and rf power amplifier (class-C FM Telephony) are:

		CCS*	ICAS†
V_P		300	300
G3		connected to cathode	connected to cathode
V_{G2}		250	250
V_{G1}		—125	—125
I_P	(ma)	70	80
I_{G2}	(ma)	15	15
I_{G1}	(ma)	5	5
Plate input	(watts)	21	24
G2 input	(watts)	2	2
P_P	(watts)	10	12

*Continuous Commercial Service
†Intermittent Commercial and Amateur Service

Maximum characteristics are:

gm (μmhos) 6,400

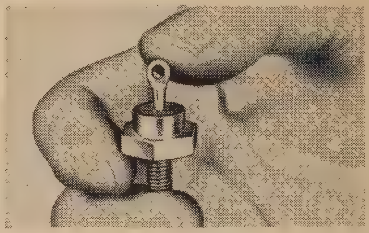
Miscellaneous

Image orthicon unveiled by G-E—type GL-7929—produces pictures of usable black-and-white quality at 1-foot-candle illumination compared to the 10 foot-candles required by standard camera tubes. The tube is electrically interchangeable with standard camera tubes. Extreme sensitivity results mainly from a high-gain thin-film target of magnesium oxide.

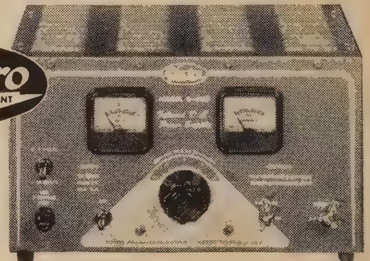
Spruce Pine Mica Co. is offering a line of 23 mica transistor washers. All are .002 inch thick and will insulate transistors from a chassis without reducing heat-sink characteristics appreciably.

Motorola is turning out three kinds of transistor mounting kits so power transistors can be mounted electrically isolated from a chassis or heat sink while excellent heat-transfer characteristics are maintained. Kits mount all power transistors in the TO-3 and TO-5 packages.

Style 33 silicon rectifier produced by Syntron is rated at 37.5 amps at 25°C



on a 5 x 5 x ½-inch copper heat sink. Piv ranges from 50–400 volts in 50-volt steps. END



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Outservices, outlasts all others in its price class. **Reserve power** to handle all servicing. **Low AC ripple**: less than 0.5% up to 5 amperes. **2% at 10 amperes. Best regulation** to operate solenoid tuning controls. **Two ranges**: 0-8 and 0-16 volts continuously variable. **10 amperes at 12 volts** continuous duty. 20 amperes intermittent. **Patented conduction cooling** lengthens rectifier life and increases capacity.

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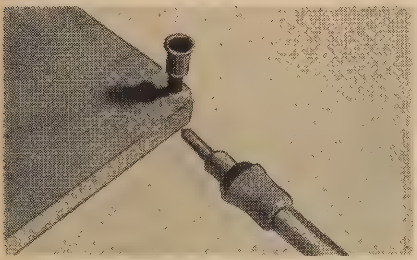
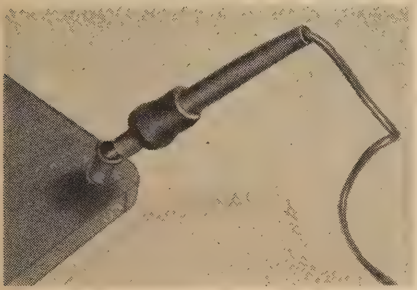
FIRST TO POWER ALL THREE!

TRY THIS ONE

PENCIL-IRON REST

Sometimes the correct place to put a pencil iron on the bench is hard to find. One excellent solution is to use a discarded 1B3 tube. Break away the glass envelope from the metal cap and skirt.





Then drill a hole in the bench large enough for the cap to be inserted in and you have a permanent iron holder that will never be in the way. With the tip of the iron inserted as the heating element, it can also be used as a miniature solder pot for multiple tinning operations, etc.—*J. Burton Burnett*

FOIL FOILS INTERMITTENTS

Does that thermal intermittent have you baffled because it has jumped back into its hiding place now that you have removed the chassis from its cabinet? Here may be the answer to your problem. Wrap all suspected tubes with aluminum foil, and set the chassis on a sheet of foil tacked to the bench. The aluminum foil will reflect dissipated heat, hasten set warmup and help ferret out the defective component.

This kink often works where soldering iron, heat lamp and hair dryers fail.—*James C. Conrad*

IMPROVE RELAY SENSITIVITY

Many factors affect the sensitivity of a relay, and most cannot readily be altered without major rebuilding. To get a great improvement, try adjusting the relay armature and contacts.

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The Fastest, Surest Method Known!

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36 most-often-needed resistors and capacitors, for fast, easy, direct substitution in all circuits. ● Eliminates searching for replacement components for test purposes. ● Avoids unnecessary unsoldering and soldering—no more solder mess. ● Pays for itself the first month in time saved. ● Flick of a switch instantly selects any one of . . .

24 RESISTORS from 10 ohms to 5.6 megohms
10 CAPACITORS from 100 mmfd to .5 mfd
2 ELECTROLYTICS, 10 mfd and 40 mfd
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Usable from 2 to 450 volts, D.C.

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Instantly tells you whether or not it is safe to replace fuse resistors, fuses, or circuit breakers. Separate red and green scale for each commercially available fuse resistor used in radio and TV. Eliminates guesswork and wasted time. Also handy for wattage checks up to 1100 watts. DEALER NET............ 8.95

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Completely isolated DC supply, with less than 0.1% ripple. Eliminates messy batteries in TV service work. Handy for alignment, AGC trouble-shooting, or checking gated sync circuits. Just dial the voltage you need, 0-18 volts, positive or negative. Covers all voltages recommended by TV set manufacturers. Size, 3½x4½x1¾". For 110-120 volts, 60 cycle AC. DEALER NET........................... 7.85

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OPPORTUNITY ADLETS *(Continued from p. 143)*

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☐ Incl. transistor & socket, diode, loopstick. In handy pakette. **$1**

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☐ Handles 10 watts. For audio circuits in cars, etc. Worth $10 ea. **$1**

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☐ W.W., & carbon, precision, power, variable, mini. types too. ½W to 50W. Reg. $17. **$1**

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☐ Matched pairs. For tuners, amps, recorders. **$1**

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☐ 16 thru 24. Plastic, glass, insulated. Asst. colors. Tinned. **$1**

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☐ Asst. colors, set screw type too! Plastic ½" to 4" dia. Some $1 ea. **$1**

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☐ Precision carbo-film resistors. Nifty lab case. 15 values. 100 ohms to 1 meg. Reg. $26. **$1**

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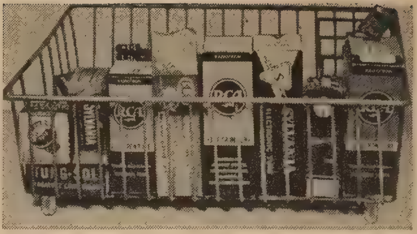
LEKTRON
131 Everett Ave.
CHELSEA 50, MASS.

The spring tension on the relay armature has an appreciable affect on sensitivity. Tension should be adjusted to the absolute minimum required to operate the relay. Spring tension is usually adjusted by bending the metal tab to which it is anchored. Sometimes the original spring has to be replaced by a lighter one that has less tension. The spacing of the relay contacts also affects its sensitivity. They should be set to the absolute minimum clearance, in the open position, that prevents arcing. Much more current is required to close a relay than to keep it closed because the magnetic flux is denser near the coil core. To increase sensitivity further, the clearance between the armature and the coil core, in the closed position, should be the absolute minimum that keeps them from touching. After these adjustments are made, the relay will be as sensitive as possible without changing the coil and core design.—*Albert J. Krukowski*

TUBE HOLDER

Most technicians have a stock of bench tubes that are used exclusively for testing. When a bad tube is located by substitution, the bench test tube is returned to its carton and a new tube from the technician's stock is installed in the set. To keep these bench tubes on hand and not all over the bench, try using an ordinary dish drainer—you can pick one up at the five and dime.—*Harry Leeper*

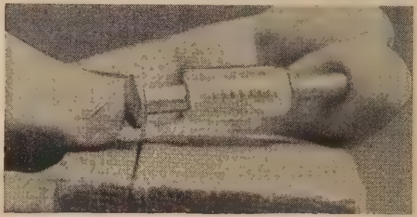


STRIPPING SHORT HARNESSED WIRES

Here's how to use automatic wire strippers to strip short lengths of wiring harness. Simply loop a piece of scrap wire around the cable and grip this scrap with one set of jaws and the short lead with the stripping jaws.
—*Hugh Lineback*

USE A BALLPOINT PEN

Technicians will have frequent need for the handy items that can be made from the sleeve of a plastic (or metal)



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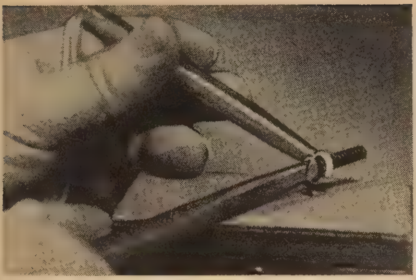
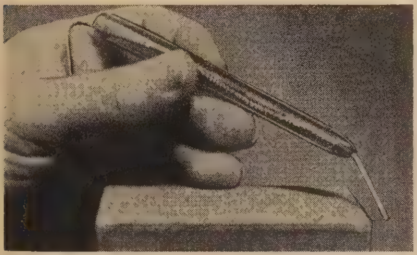


ballpoint pen. An insulating sleeve of any length up to 5 inches can be made from the sleeve of a discarded plastic pen. Insulators for electrical testing prods are another possibility.

Run the ends of a length of string through a ballpoint-pen sleeve, and the resulting loop at one end of the barrel will make a holder for a screw or bolt that must be inserted into an almost inaccessible hole on a TV chassis. For somewhat similar use, insert a straightened-out paper clip in such a sleeve and use it to get a drop or two of light oil to a normally inaccessible spot.



Convenient-size bushings and insulated feet for any lightweight chassis are other items that can be made in a minute from these handy sleeves. For insulating feet, thread the inside of the sleeve for a proper-size screw.—*Glen F. Stillwell*

INVERTED CARTONS MARK EMPTIES

To tell which tube cartons in our caddy are empty, we always put the empty cartons back so that the writing on the end flap is upside down. This makes it a much easier job when the caddy is refilled, and eliminates the possibility of cartons being carried around empty.—*John C. Alexander*

VIALS HOLD BATTERIES

I have found that small plastic vials that are used as containers for five and dime store items can be made into ideal battery holders for compact transistor circuits. The vials are a perfect fit for penlight batteries and are very easily fitted with screw contacts at either end for voltage pickup.

If exhausted batteries are accidentally left in the plastic holders, there's no danger of acid leakage ruining the holder. This is an advantage over metal types that are soon destroyed by acid.

The screw terminals at either end can be tightened to hold the batteries very securely in the case, thus assuring positive contact at all times.—*John C. Abram*

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more than 25,000 now in use

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Ask any serviceman who owns one . . . or try one for just one day of servicing in your shop. You'll see for yourself how much time the LC3 can save *you*. Checks for leakage between all elements, whether caused by gas, grid emission or foreign particles. Also checks leakage on all capacitors with voltage applied—including electrolytics. Provides instant filament checks in "Fil-Check" position—no need for a second filament checker. One spare pre-heating socket and new roll chart prevent obsolescence. New charts provided—no charge. Leakage sensitivity; 100 megohms, control grid to all other elements; 50,000 ohms, heater to cathode. Size, 7x6x3½". Wt., 3 lbs. For 110-120 volts, 60 cycle AC. DEALER NET 28^{95}

NOW . . . checks 172 tube types—more than any other checker of this type.

NEW . . . replaceable Roll Chart prevents obsolescence.

Check Filaments of All Receiving Tubes and Picture Tubes

FC4 FILAMENT CHECKER

For fast, easy checking of all tube filaments, without pulling chassis. Neon light goes out if tube filament is good. Also acts as continuity and voltage tester. Neon lamp glows when 115 v. AC is applied by cheater cord, providing a check on power to TV set. Size, 3⅛x4x1". With leads. DEALER NET....... 2^{95}

Check 3- and 4-Prong Vibrators . . . Faster, Easier

VB2 "VIBRA-DAPTOR"

Plugs into any tube checker; ideal for use with LC3 above. To check 6-v. vibrators, set for 6AX4 or 6SN7; for 12-v. vibrators, set for 12AX4 or 12SN7. Two No. 51 lamps indicate whether vibrator needs replacing. Instructions on front panel. Steel case. Size, 1½x1½x3" DEALER NET................ 2^{75}

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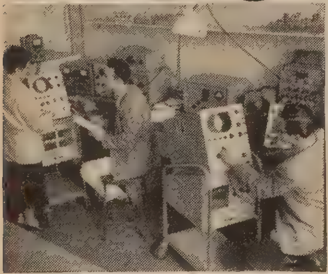

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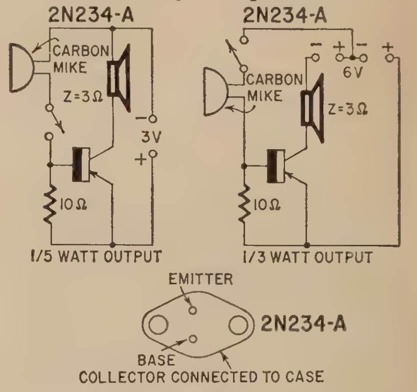
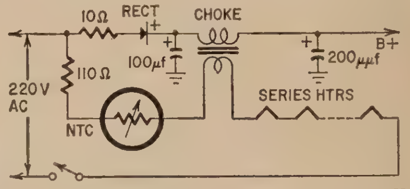
TWO MEGAPHONES

These 1-transistor megaphones put out a surprising amount of power, considering the simplicity of their circuits. Mount the battery and speaker in a box with the microphone on a long wire away from the box to prevent feedback and oscillation. A spring return push-to-talk switch will conserve battery life. —*Bendix Semiconductors*



HUM-CANCELING CIRCUIT

This arrangement is found in some German Union television receivers. The supply is an ac–dc type and fed from the standard German 220-volt line. A series heater string is used, and heater current also flows through a small additional winding on the filter choke. Correctly connecting this winding introduces hum, opposite in phase to hum from the half-wave rectifier. Complete cancellation is impossible because of the nonsinusoidal rectified waveform, but the improvement is marked and economical to get.—*A. V. J. Martin*



HEADPHONES FOR TV LISTENING

An interesting method of adding headphones to a TV set was shown in the January, 1960, issue of RADIO-ELECTRONICS, page 56. Since then, I have come up with a variation of this system that might be preferred by some readers.

This time crystal phones are connected to the output of the audio output tube through a blocking capacitor,

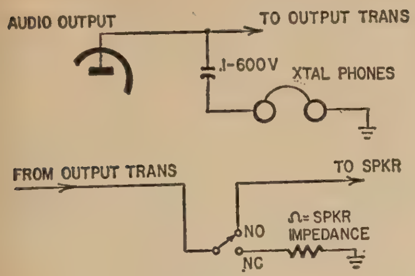


Fig. 1

0.1 μf 600 volts (see Fig. 1). The phones are on all the time, only the speaker is switched on and off—lifting the earphones off their rack turns the speaker off; replacing them turns the speaker on once again. A spdt Microswitch built into the earphone bracket handles the switching (see Fig. 2). You can also use the switch arrangement shown in the January issue.

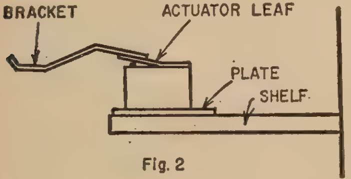


Fig. 2

The main drawback to this system is in connecting the capacitor to the output tube's plate. A technician can wire it in directly, but the do-it-yourselfer might not care for the job. To avoid pulling the chassis, use a test adapter or make one yourself. Then simply connect the takeoff capacitor to the adapter. Now pull the output tube, insert the adapter, reinsert the tube and you're in business.—*William B. Rasmussen*

END

50 Years Ago

In Gernsback Publications

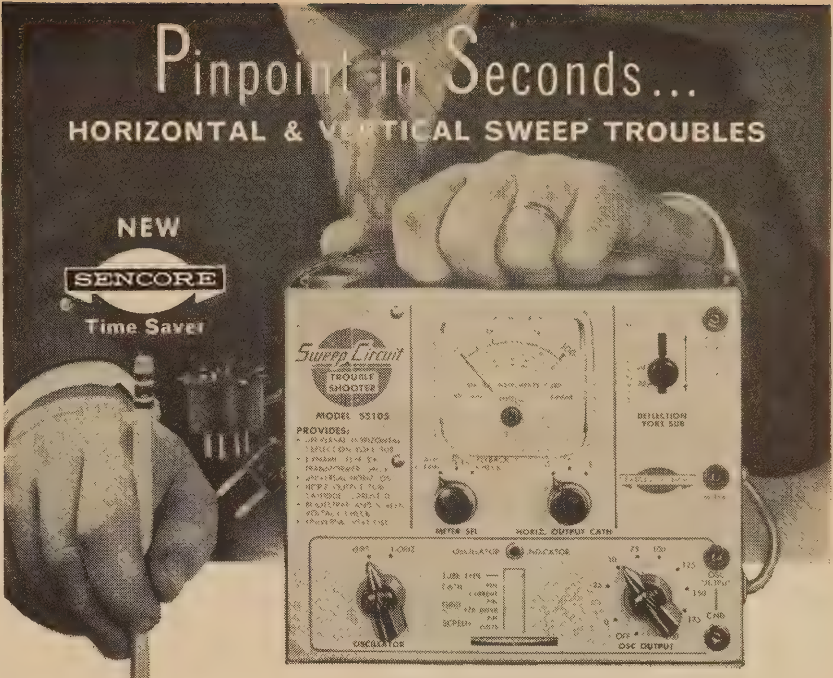
HUGO GERNSBACK, *Founder*

Modern Electrics	1908
Wireless Association of America	1908
Electrical Experimenter	1913
Radio News	1919
Science & Invention	1920
Television	1927
Radio-Craft	1929
Short-Wave Craft	1930
Television News	1931

Some larger libraries still have copies of Modern Electrics on file for interested readers.

In February, 1910, *Modern Electrics*

Dr. de Forest's New Radio Telephone.
Portable Receiving Set, by Edward Featherstone.
The New Rossi Detector, by A. C. Marlowe.
Pocket Wireless, by the Brussels Correspondent.
Electrolytic Detector Operates Relay.
Duplex Wireless.
A Tuning Transformer, by Richard H. Foster.
Apartment Aerial Pole, by Robert D. Skelly.
An Efficient Sending Condenser, by Maurice Friedman.
Selective Detector Board, by R. Fulton Adams.
Variable Sending Condenser, by Fred Wadsworth.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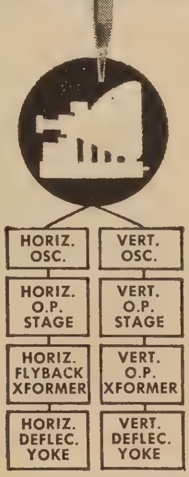

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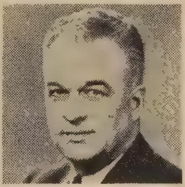
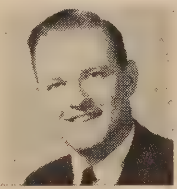
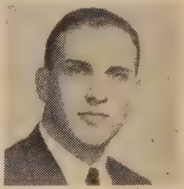
BUSINESS and PEOPLE



Einar G. Carlson has been elected director and secretary of Hickok Electrical Instrument Co., Cleveland, Ohio. He is a partner in the law firm of Pennell, Carlson & Rees, the company's counsel. **Henry Packard White,** chief engineer and owner of H. P. White Laboratory, and **E. G. Perkins,** president of Supreme Electronics Corp., a Hickok subsidiary, were also named to the board of directors.

Thomas S. Knight Jr. (left), was named sales manager, General Electric receiving and TV picture tubes and hi-fi components in the Owensboro, Ky., plant. Since 1955 he has been distributor sales manager, serving franchised parts distributors in Florida and southern Georgia. **Charles J. Coward** has been named general manager of the newly formed audio products section of General Electric, Housewares & Radio Receiver Div., Bridgeport, Conn. He had been serving as a consultant in the marketing services division before this appointment.





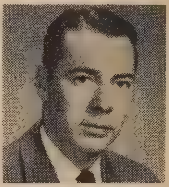
Howard D. Vann was appointed director of advertising and public relations for Globe Electronics, a recently acquired division of Textron Electronics, Inc. He was formerly director of community relations for Mutual and United of Omaha.

Warren E. Dalbke was appointed Midwest regional manager, equipment sales, for CBS Electronics, Danvers, Mass. He had been district manager, equipment sales.

Frank A. Comerci joined Audio Devices, Inc., New York, as senior project engineer in the Stamford, Conn., lab. For the past 12 years he had been in charge of the Communications & Acoustics Section at the New York Naval Shipyard, Brooklyn, N. Y.

John Pacconi, Jr., is now associated with Glaser-Steers Corp., Newark, N. J., as customer service manager. He was previously with Lafayette Radio.

Ken Burton is the new sales manager for Duotone Co., Keyport, N. J. He has been active in the needle business for the past 6 years.



William N. Latshaw joined Heath Co., Benton Harbor, Mich., in the newly created position of advertising production manager, assisting Clifford M. Edwards, director of advertising. He comes to Heath from MacFarland, Aveyard Advertising Agency in Chicago.

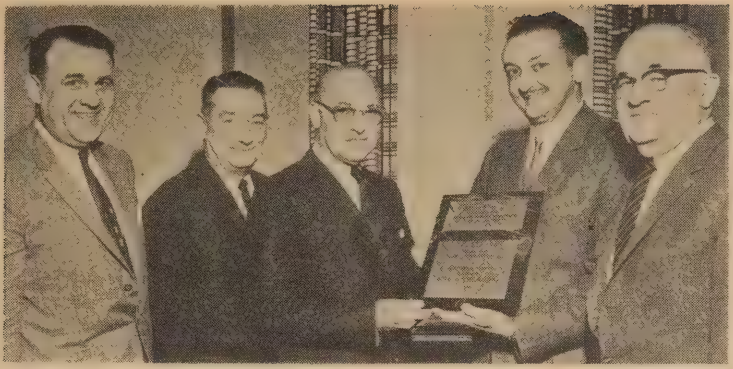
Winegard Co., Burlington, Iowa, is sponsoring a "Paul Harvey News" program over 210 local ABC radio stations to promote its Color-Ceptor antennas. A special cooperative advertising program is available to dealers. Winegard's advertising campaign in national magazines and its dealer sales aids will be continued. Paul Harvey (left), is shown in a recent tour of the Winegard plant with John R. Winegard, company president.

Ben Braun joined I. H. Manufacturing Co., New York, a subsidiary of Industrial Hardware Corp., as director of sales. He had been director of marketing for Telematic Co.

Ernest F. Tonsmeire was named controller of Raytheon Co., Receiving Tube Div., Quincy, Mass. He joined the company from Sylvania's Home Electronics Div., where he was controller of branch operations.

Edward Manville was appointed sales manager of the Communications Products Div. of Vocaline Co., Old Saybrook, Conn., and **Ralph Routsong** was named marketing manager.

Sylvania Electronic Tubes, division of



Sylvania Electric Products, Inc., was presented the NATESA Friends of Service Management plaque for the ninth consecutive year. Matthew D. Burns (third from left), Sylvania Electronic Tubes president, is shown accepting the award from Mac Metoyer, NATESA president, as other NATESA and Sylvania executives look on.

Electro-Voice, Inc., Buchanan, Mich., has expanded its product line to include replacement needles, according to a statement by Larry LeKashman, vice president of marketing. The new replacement line will meet requirements for 97% of needles now in use.

Haskel Blair was elected president of University Loudspeakers, Inc., White Plains, N. Y., a subsidiary of Ling-Altec Electronics, Inc. He succeeds **Sidney Levy** who will continue as executive vice president and director of engineering. Blair has been active in electronics since 1923, most recently as a manufacturer's rep.

EIA PRODUCTION & SALES

(10 months)	*1959*	*1958*
TV picture-tube factory sales	7,864,893	6,814,166
Receiving-tube factory sales	358,477,000	333,258,000
TV set production	5,195,440	4,067,606
Radio production	12,722,970	8,904,772
FM radio production	430,763	235,647
TV retail sales	4,448,901	3,991,530
Radio retail sales	6,125,790*	5,241,629*

*Excluding auto radios.

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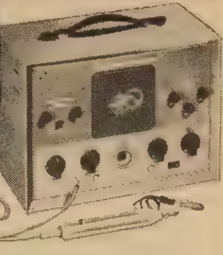

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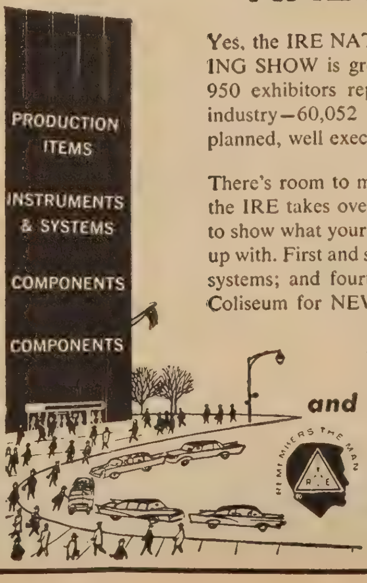

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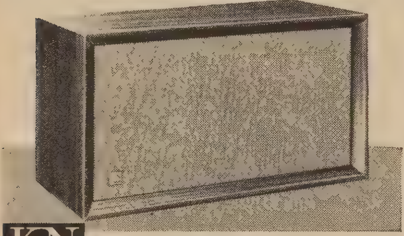

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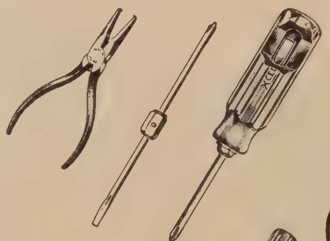

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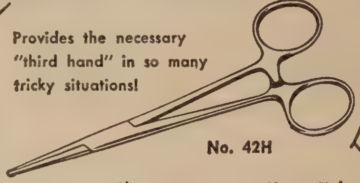

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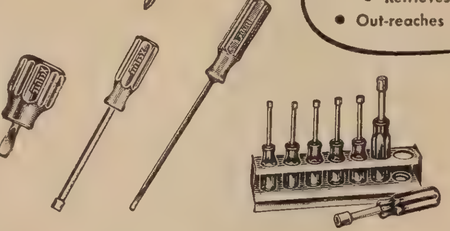

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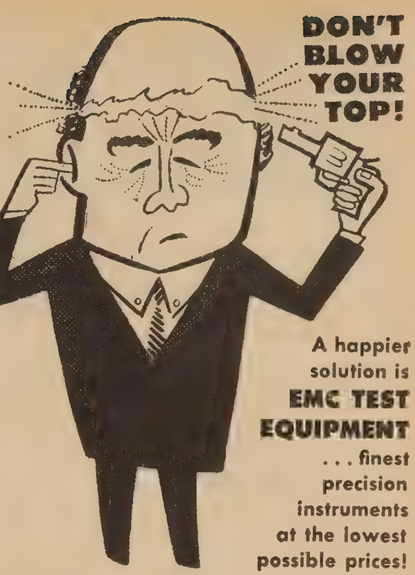

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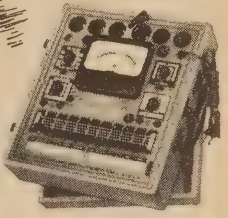

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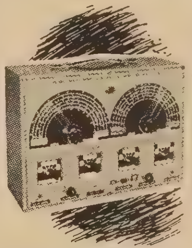

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ELECTRONIC COMPONENTS HANDBOOK (VOL. 3), edited by Keith Henny, Craig Walsh and Harry Mileaf. McGraw-Hill Book Co., 330 W. 42 St., New York, N. Y. 8½ x 11 in. 180 pp. $10.

Vol. 3 completes the series prepared to help designers of military and commercial equipment in selecting components for maximum reliability. It provides data on transformers, inductors, magnetic amplifiers, saturable reactors, connectors, wire and cables, terminals and terminal boards, tube shields and hardware. The effects of altitude, humidity, shock, vibration and other unfavorable conditions are discussed.

TRANSISTOR CIRCUITS, by K. W. Cattermole. MacMillan Co., 60 Fifth Ave., N. Y. 11, N. Y. 5½ x 8½ in. 442 pp. $14.

This book is for readers familiar with tube circuits and math. It begins with the theory and manufacture of semiconductors. Amplifiers, binary circuits, wave generators, modulators, etc. are analyzed, and equations derived for them. Mathematical design data appears in several appendices.

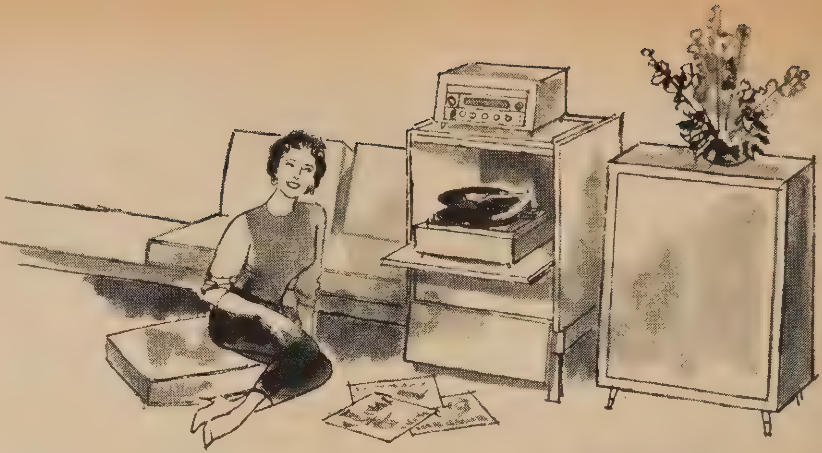
R-L-C COMPONENTS HANDBOOK, by David Mark. John F. Rider, Publisher, Inc., 116 W. 14 St., N. Y. 11, N. Y. 5½ x 8½ in. 146 pp. $3.50.

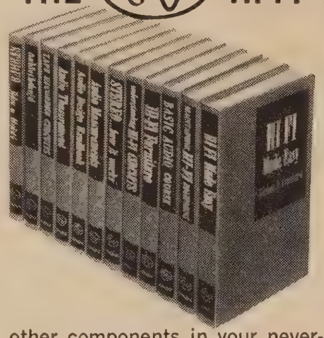
Some technicians believe that a capacitor is just a capacitor. But there are many different kinds, and for any given application one kind is best. The same holds for resistors and inductors. This book describes the characteristics and applications of R, L and C components, including thermistors and transformers. Temperature effects, tolerance and color codes are discussed. This book will help you make the correct replacement in every circuit.—*IQ*

ELECTRICAL ENGINEERING, Second Edition, by William H. Erickson and Nelson H. Bryant. John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N.Y. 5¾ x 9 in. 614 pp. $8.

These authors have written about circuits, electronics and machines especially for engineering students majoring in subjects other than electricity. They discuss and analyze transformers, motors, control equipment, tubes and

(*Continued on page* 158)





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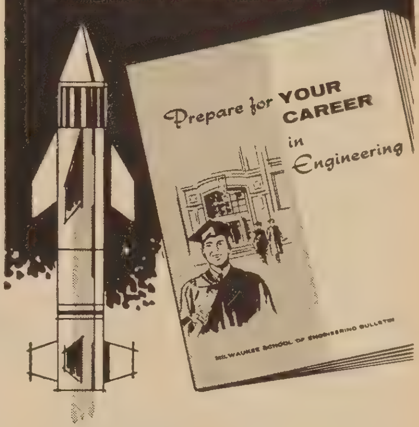
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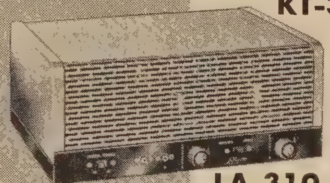

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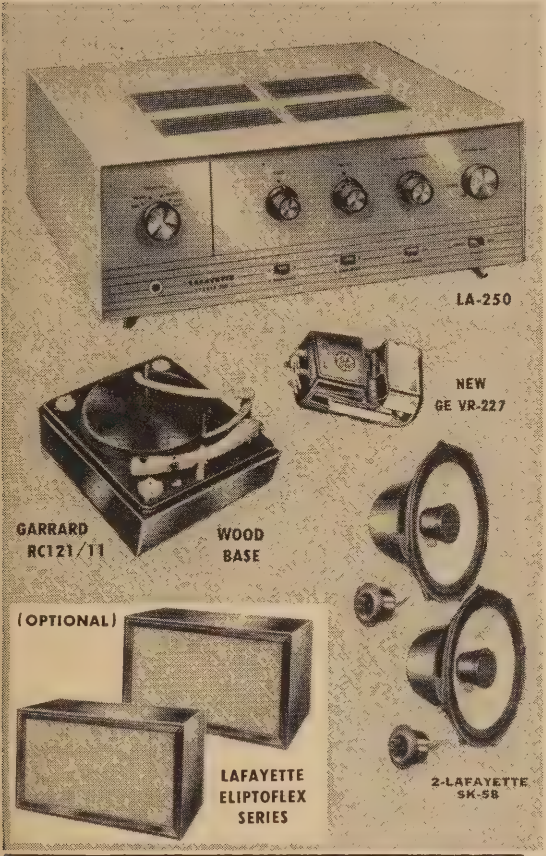

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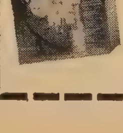

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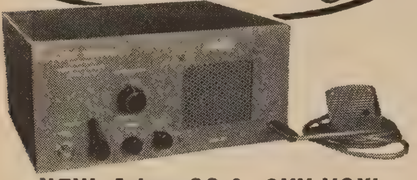

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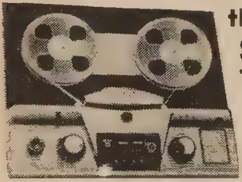

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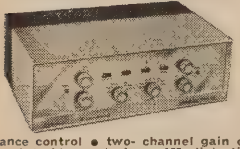

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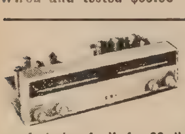

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transistors, meters and amplifiers, both theoretically and as found in use.

The book is clear and complete. It includes problems with answers at the end of each chapter.

MAGNETIC-AMPLIFIER CIRCUITS, by William A. Geyger. McGraw-Hill Book Co., 330 W. 42 St., N. Y. 36, N. Y. 6 x 9 in. 394 pp. $7

MAGNETIC AMPLIFIER ENGINEERING, by George M. Attura. McGraw-Hill Book Co., 330 W. 42 St., N. Y. 36, N. Y. 6 x 9 in. 220 pp. $7.50

Magnetic Amplifier Circuits is a practical and comprehensive book for circuit designers. It uses a minimum of math, but relies heavily on diagrams and curves. The book discusses basic and complex circuits including non-feedback, feedback and self-balancing types, and analyzes them in clear fashion. The author aids clarity by his listings of advantages, modes of operation, characteristics and measurements where applicable. An extensive bibliography (including patents) follows each chapter.

Magnetic Amplifier Engineering is for engineers and deals with theory and principles. It starts with magnetic and reactor theory, then discusses core material and measurements, saturable reactors and rectifiers. The second half of the book discusses basic amplifiers, controls and output circuits.

The author compares the magnetic amplifier with other types, and includes new material on hybrid amplifiers. The method of analysis used here is basic and can be applied to any magnetic amplifier, however complex.

101 WAYS TO USE YOUR OSCILLOSCOPE, by Robert G. Middleton. Howard W. Sams & Co., Inc., Indianapolis 6, Ind. 5½ x 8½ in. 180 pp. $2.50.

This working handbook shows how to use your scope in many new ways. The 101 applications deal particularly with TV receivers and include waveform measurement, signal tracing, circuit adjustments, balancing indication, etc.

Tests are grouped under headings like video amplifier, sync circuit, chroma, rf and if. Diagrams show how to set up the equipment for test, and photos show the resultant pattern. This book will reduce your servicing time and effort.—*IQ*

GASEOUS CONDUCTORS, by James Dillon Cobine. Dover Publications, Inc., 180 Varick St., New York, N. Y. 5¼ x 8 in. 606 pp. $2.75.

This text for the specialist and graduate engineer requires a knowledge of at least calculus. It begins with basic theory and general laws of gases and goes on to discuss space charge, emission, glow, corona and arc discharges. Finally, it deals with applications like rectifiers, glow and fluorescent lamps, circuit breakers, lightning arresters, welding and voltage regulation.

The author seems to have covered the field very well. The book ends with problems, math tables and selected experiments. END

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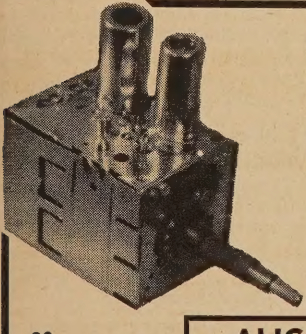

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- **New — Sonotone Rechargeable Battery.** Plug in any AC outlet to recharge. Use 100's of times. Orig. jobber boxed. $7.95.
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- **Double-Spaced Variable Capacitor.** 14 Min. to 64 Max. Mmfd. Will handle up to 100 watts AM. Ceramic insulation. $1.00.
- **Choke.** .35 Hy @ 2 Amps. DC resistance: 2.2 Ohms. Herm. sld: $4.25. Open Frame: $3.50.
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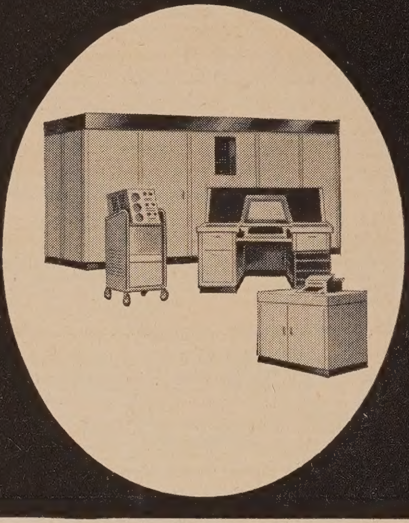

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NOTE: Model 331 has momentary-on, spring-return switch, is furnished with hang-up bracket. Cable provides for audio and relay connections. All other models have slide switch with "lock-on" position, are complete with lavalier and stand adaptor with 5/8"-27 thread.

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REDUCE DAMPER TUBE CALLBACKS

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Here are some important facts about damper circuits

In the *transformer-coupled* circuit, Figure 1, the damper cathode is connected to the "low" (Boost) side of the sweep-output circuit. The voltage difference between cathode and ground is usually less than about 600 volts.

In the *direct-drive* circuit, Figure 2, and in the *auto-transformer circuits*, Figures 3 and 4, the damper cathode is connected to a "high" point in the sweep-output circuit. The peak voltage difference between cathode and ground may be several thousand volts.

Because the damper cathode is "above ground" by several hundred to several thousand volts, care must be taken to prevent voltage breakdown between heater and cathode in the damper tube. Two basic methods are used:

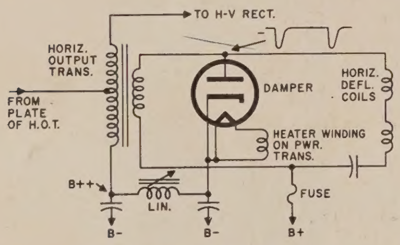

TO H-V RECT.
HORIZ. OUTPUT TRANS.
FROM PLATE OF H.O.T.
DAMPER
HORIZ. DEFL. COILS
HEATER WINDING ON PWR. TRANS.
B++
LIN.
FUSE
B-
B-
B+

Figure 1. Transformer-coupled horizontal-output circuit. Note that the damper tube heater is connected to the cathode.

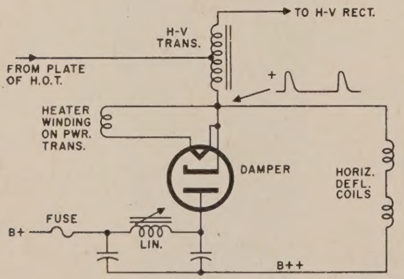

TO H-V RECT.
H-V TRANS.
FROM PLATE OF H.O.T.
+
HEATER WINDING ON PWR. TRANS.
DAMPER
HORIZ. DEFL. COILS
FUSE
B+
LIN.
B++

Figure 2. Direct-drive circuit. In some variations of this circuit, a capacitor is connected between heater and cathode in place of the direct connection. The capacitor serves to reduce the pulse-voltage difference between heater and cathode.

In one method, shown in Figures 1, 2, and 3, heater is connected to cathode. This connection eliminates voltage difference between heater and cathode, but it also makes the damper tube heater circuit "hot" with respect to ground. For this reason it is necessary to use a separate secondary winding on the power transformer just for the damper heater. This winding, and its connecting leads, must be insulated to withstand the peak voltage difference between cathode and ground.

In the circuits of Figures 1, 2, and 3, if the damper heater winding becomes grounded, or arcs to ground, high current will flow from B+ to ground through the damper tube, and the fuse will blow. Correction of this trouble usually requires costly and time-consuming replacement of the power transformer.

The second method, shown in Figure 4, takes advantage of the fact that modern damper tubes, such as the RCA-6AX4-GTA, 6AU4-GTA, and 6DE4, are designed to withstand high-amplitude positive pulse voltages between heater and cathode. These RCA tubes make it possible to ground the damper heater circuit, and for this reason, the damper heater may be connected to the regular 6.3-volt-ac grounded-heater circuit, thus eliminating the need for an additional high-voltage-insulated secondary on the power transformer.

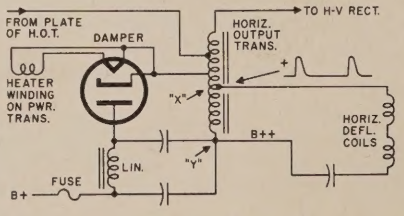

FROM PLATE OF H.O.T.
TO H-V RECT.
DAMPER
HORIZ. OUTPUT TRANS.
HEATER WINDING ON PWR. TRANS.
"X"
+
HORIZ. DEFL. COILS
B++
LIN.
"Y"
FUSE
B+

Figure 3. Auto-transformer circuit in which the damper tube heater is connected to the cathode. In some variations of this circuit, the heater is connected to a lower-voltage tap, "X" or "Y", in order to make the heater negative with respect to the cathode, and to reduce the shunting effect of the heater-circuit capacitance.

From a servicing viewpoint, the second method has definite advantages:

In the circuit of Figure 4, if the insulation between heater and cathode should break down, high current will flow from B+ to ground through the damper tube, and the fuse will blow, but the trouble can be corrected easily, quickly, and inexpensively by installing a new RCA damper tube. This is a lot easier and cheaper than installing a new power transformer!

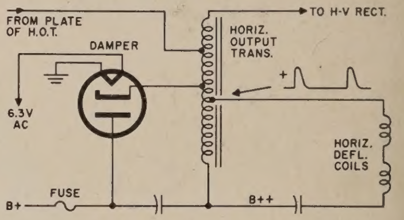
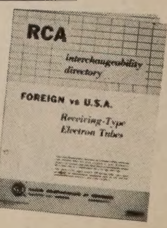

FROM PLATE OF H.O.T.
TO H-V RECT.
DAMPER
HORIZ. OUTPUT TRANS.
6.3V AC
+
HORIZ. DEFL. COILS
FUSE
B+
B++

Figure 4. Modern auto-transformer circuit in which the damper tube heater is grounded. Tubes such as the RCA-6AX4-GTA, 6AU4-GTA, and 6DE4, which are designed to withstand high peak pulse voltage between heater and cathode, are required in this circuit.

Momentary arcing, or flashover, in a horizontal output tube or damper tube may be "self-correcting", that is, the flashover may not occur again. But the momentary flashover results in a heavy surge of current which will blow the conventional type of fuse. You can eliminate such unnecessary fuse failure by using RCA "chemical" fuses in the horizontal-output circuit. Three varieties, RCA Stock Nos. 104295, 105041, 105042, are available at your RCA distributor.

RCA damper tubes are designed to give long, dependable service—eliminate costly callbacks—prevent loss of your time and profits. Take for example the RCA-6DE4 and RCA-17DE4. These tubes can supply a peak plate current of 1100 milliamperes and withstand a heater-to-cathode potential of 5000 volts—with a 900-volt dc component! Assure your customers of this kind of performance by asking your distributor for RCA damper tubes.

Get your copy of RCA's Foreign-vs-U.S.A. Receiving Tube-Interchangeability Directory (ICE-197) from your authorized RCA Tube Distributor.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